MEETING FUTURE ENERGY NEEDS

DRAFT DEMAND/SUPPLY PLANNING STRATEGY

REPORT 666 SP

December, 1987

ontario hydro

System Planning Division

FOREWORD

This Draft Demand/Supply Planning Strategy was accepted by the Ontario Hydro Board of Directors at their November 16, 1987 meeting as a reasonable basis for public review and discussion on the strategic directions Ontario Hydro should follow. The purpose of issuing this draft strategy is to provide a focus for public discussion. Following the review process established by the Ontario government, the strategy will be modified as necessary. The final strategy will be used as a basis for preparing annual definitive long term plans.

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Ce rapport est également publié en français.

ontario hydro

ACKNOWLEDGEMENT

The Draft Demand/Supply Planning Strategy is a result of Phase II of the Meeting Future Energy Needs or Demand/Supply Options Study. This report was written by authors in several parts of Ontario Hydro, who would like to acknowledge the contribution of the many people throughout the Corporation who made valuable comments and suggestions.

DRAFT DEMAND/SUPPLY PLANNING STRATEGY SUMMARY

Introduction

From the mid 1970s to the early 1980s growth in electricity demand was lower than forecast. This led to delays in completing, and in some cases outright cancellations of, generating plants under construction and mothballing of some existing plants. By 1984 it was becoming clear that planning to meet increased needs should resume because forecasts indicated a possible shortage of generating capacity in the mid to late 1990s. A study was started called Meeting Future Energy Needs, or the Demand/Supply Options Study. While the study does consider traditional as well as less traditional supply options, increased effort has been put into developing new approaches to help customers reduce their electricity consumption. These new approaches are generally called demand management. This report describes the studies that have been done, the public input received and presents the resulting Draft Demand/Supply Planning Strategy that is being published for further public review.

Long Range Planning

Ontario Hydro is a publicly owned electricity utility which exists to meet the requirements of the Ontario community for electric service. To carry out this responsibility effectively, electricity planning must look many years into the future because decisions taken today on new demand management initiatives or new or refurbished generating plants will affect reliability, operating costs, environmental impacts, and electricity rates for several decades to come. Uncertainty about the future makes long term planning difficult and detailed plans must be regularly revised to respond to changing circumstances. However, despite the uncertainty, the responsibility remains to have strategies and plans that will shape the future electricity system to meet the province's need for electricity service reliably and economically. This Draft Demand/Supply Planning Strategy is intended to provide a constant set of strategic objectives and priorities that can guide the continually evolving planning process.

Ontario Hydro has the responsibility to plan the electricity system and does so by considering the needs and values of the Ontario community. This draft strategy is based on an initial public review of the options and will be the subject of further public and government review. In addition, many approvals are required from government and public bodies such as the Environmental Assessment Board, that provide checks and balances to ensure that electricity planning is conducted in an environmentally and socially responsible way.

Ontario Energy Needs and Resources

It is important that electricity planning be carried out with an understanding of Ontario's total energy needs and the resources available to meet them. Oil and natural gas supply more than half of Ontario's total energy needs although they are relatively scarce energy resources and are almost entirely imported. Hydraulic energy and uranium are indigenous to Ontario and are most conveniently used through conversion to electricity. Hydraulic energy is renewable and uranium is relatively plentiful. The potential for new hydroelectric development is limited by the availability of suitable sites. Coal is plentiful in North America but is imported into Ontario. Coal, apart from its uses in heavy industry such as steel making, is most conveniently used for generating electricity.

Forecasting Energy Demand

Forecasting energy demands requires an understanding of underlying demographic, economic and energy use trends. Energy demands per capita are high in Ontario partly because of the intensity of economic activity and climatic conditions. However, there has been a trend to improving energy efficiency and this trend is expected to continue. Increasing energy efficiency is one part of conservation which is the wise use of all resources. Energy conservation also includes the efficient use of energy to reduce the use of other scarce resources, the substitution of plentiful fuels for scarce fuels and the substitution of the efficient use of one fuel for the inefficient use of another. All these aspects of conservation are important to include in electricity planning.

Forecasts of electricity use take into account these general trends and specific information about trends in electricity use. Although the annual electricity growth rates, expressed as a percentage increase on the previous year's demand, are now lower than they were prior to the mid 1970s, annual growth in the actual amount of electricity used is about the same as it has been for the past 25 years. Electricity has been gradually increasing its share of the energy market because of its convenience and its relative price stability due to the use of plentiful and renewable primary resources. This has created opportunities to increase efficiency by substituting efficient electricity use, often through electro-technologies, for inefficient use of other fuels. Nevertheless, with increasing efficiency of use, it is expected that growth in electricity use will be slightly lower than the growth of the economy in the future. This is a change from past trends when the electricity growth rate was generally higher than the growth of the economy. Current electricity load forecasts clearly recognize that there is a wide band of uncertainty. Planning must therefore strive for flexibility to respond to a variety of circumstances.

The Existing Electric System

Another basic input to planning for future needs is the nature of the existing system. Ontario Hydro's generating system is a mix of hydroelectric, coal and uranium fuelled stations together with some oil and gas fuelled plant. About 5% of electricity needs is met by generation which is independent of Ontario Hydro. This independent generation is mostly hydroelectric and natural gas or wood waste fuelled cogeneration. The generating system must be planned in coordination with plans for the transmission and distribution systems. Most of the distribution facilities are owned by municipal utilities who serve urban retail customers.

The existing and approved system will play a major role in meeting the electricity needs for the next twenty years. Much of the system capacity is aging and will require modification, such as acid gas emission controls, and rehabilitation to continue to provide reliable, low cost, environmentally acceptable service.

Needs for New Demand or Supply Resources

Existing and approved demand management programs and generating plants are sufficient to reliably meet future needs until about 1996 assuming most likely load growth. With lower load growth, no new demand management programs or generating plants are required before 2010 while higher load growth would require additional demand or supply resources in the early 1990s. By 2010 the additional requirements, assuming most likely load growth, would be about 40% of the current peak load, meaning about 8000 MW of new dependable demand or supply resources. With the upper scenario the additional need would be about 22,000 MW, which is more than the current peak load.

Evaluating the Options

Evaluating different demand and supply options and plans requires consideration of many sometimes conflicting factors. All the relevant costs must be assessed and compared, including the effect on electricity rates. The flexibility to adjust to changing circumstances, the time required for implementation, the security of fuel supply, and other business and strategic risks must be included. In addition the evaluation must consider external factors including environmental impacts, effects on the provincial economy, public acceptability and the contribution to customer satisfaction.

With an increased emphasis on demand planning, new factors affecting customer satisfaction must be taken into account. In the past, utilities' involvement in how customers choose and use electrical equipment and appliances has usually been limited to information and advertising programs. With increased emphasis on demand management, customers may be given direct financial assistance to help them improve efficiency so that they receive the same level of service with less electricity. Where utility funds are used to assist customers who participate in the efficiency program, the cost must be recovered through electricity rates from all customers. Demand planning must be carried out in a way that is acceptable to both participating and non-participating customers.

Demand and Supply Options

An initial review was made of all the demand and supply options that might make a significant contribution to electricity needs in the next 20 years. A number of demand and small scale generation options were shown to have potential for development at average lifetime energy costs that are comparable to large scale conventional hydroelectric, coal, and nuclear stations.

We estimate there is a potential of 1000 to 4000 MW of efficiency improvements by the year 2000 with an average lifetime energy cost in the same range as the conventional hydraulic, fossil and nuclear supply options. Those demand management initiatives which affect municipal customers must be implemented in cooperation with municipal utilities. Part of this potential could be achieved by government energy efficiency standards. In addition to potential efficiency improvements, the need for new capacity can be reduced by shifting electricity use from peak to off-peak periods. There is a useful potential for shifting about 1000 MW by the year 2000.

Cogeneration - particularly if waste fuels are available - and redevelopment of small-scale hydroelectric plants can also make useful, but limited, contributions.

Purchase of up to 4000 MW of power from new hydroelectric plants in Quebec or Manitoba is another option being discussed with these provinces.

Wind and solar are too costly to be economic in southern Ontario. However, they may make useful contributions to remote northern communities to save on expensive diesel-fuelled power.

Public Consultation

After the initial review of options, Ontario Hydro began a public consultation program to identify the opinions, concerns and priorities of customers, individuals and organizations throughout the province. This information was used in formulating the draft strategy. A variety of techniques were used, including customer opinion surveys, discussions with interested provincial organizations, meetings with community leaders and municipal utilities and a hearing before the legislature's Select Committee on Energy.

While there was considerable diversity of opinion, some priorities for electricity planning emerged with most participants. Priorities included maintaining reliability of supply and reasonable electricity rates while emphasizing environmental protection. Encouraging customers to use electricity wisely and efficiently is important. People see a need to create jobs and economic benefits for Ontario. The use of indigenous resources can contribute to this objective and also help ensure security of supply. A need is seen to constrain Hydro's borrowing and increases in debt. Maximizing public safety is also an important priority. Demand or supply options should be selected to ensure flexibility and use a diversity of energy resources.

For demand management, customers want a range of voluntary, rather than mandatory programs, that will not require lifestyle adjustments and will result in a fair sharing of costs and benefits. To meet longer term needs, there should be emphasis on demand management before commitments are made to supply options. When supply is required, there should be emphasis on smaller, more flexible supply options and hydraulic, before large nuclear or fossil plant options.

Analysis of Representative Plans

Based on the results of the initial review of the options, a more detailed set of internal studies was conducted to examine the effects of combining options in a series of representative plans. These studies showed the effects of different types of strategies on electricity rates, environmental impacts, borrowings, etc. In addition, the flexibility to adjust to unexpected changes in conditions was studied. The plans ranged from depending mostly on demand management to depending mostly on major traditional supply options.

The studies showed that demand options can make an effective contribution to meeting electricity needs. With most likely load growth, they can defer the need for new supply by three to ten years, depending on the degree of customer acceptance and the incentive levels offered. Moderate levels of incentives for demand management could be offered with electricity prices rising at less than the inflation rate in the 1990s. High levels of incentives would mean higher rates but can have positive impacts on the provincial economy and can also tend to further reduce acid gas emissions in the next decade. There tend to be negative economic impacts if electricity prices are increased above production costs to discourage electricity use.

New hydraulic generation and independent generation can contribute to an economic resource mix but the number of undeveloped economic sites is limited.

The analysis of the economics of major fossil and nuclear stations tended to confirm previous studies showing that nuclear plants are expected to lead to lower long term costs. While new coal plant has a part to play, particularly if load growth is higher than forecast, excessive use may cause difficulty in meeting acid gas emission regulations even with state of the art control equipment. The economics of major purchases could not be assessed because negotiations with Manitoba and Quebec are still continuing.

The studies showed that the length of time and uncertainties of the approval process are a major source of inflexibility and increased costs when planning for major supply facilities is required.

In general, the study of representative plans showed that there are a number of ways to meet the most likely growth. While lower growth has its own challenges, providing sufficient resources in time is not a problem. However, if higher growth should occur, a variety of options will need to be developed and the time to do it will be short. This confirms the need to establish, with appropriate public input, the strategies for the development of demand and supply options.

Demand/Supply Planning Strategy

The report presents a proposed demand/supply planning strategy. The rationale for the proposed strategy is explained, based on the considerations raised in the report and very briefly summarized in the preceding paragraphs. The strategy reemphasizes the principles of customer satisfaction, reliable supply, low customer cost, the need to ensure environmental and social acceptability and the continuance of rates based on cost.

General strategies are included that recognize that the selection of a mix of demand and supply options should aim to provide electricity service at the lowest total customer cost. Total customer costs of electricity service include the cost of customer's electrical equipment as well as the costs of generating and distributing electricity. The costs evaluated must also include the cost of meeting social and environmental requirements. Other general strategies recognize the need to deal explicitly with uncertainties in the load forecast and the general desire to give preference to indigenous and renewable or plentiful resources.

The detailed strategies are too numerous to include in a short summary. However, compared to previous Ontario Hydro practice, they place increased emphasis on demand options. Demand options are to be pursued to the full extent they are economic compared to the available supply options. The intent is to give priority to economic demand options, independent generation and hydroelectric generation over further major fossil or nuclear plant. Even with modest load growth, increasing work in these areas will be required in the near future. The strategy discusses the means to implement demand options including technical research, market development, promotion, education, rate incentives, efficiency standards and other financial incentives such as loans and grants. The strategy includes principles that will help to define appropriate levels of incentives that will balance the need to achieve economic efficiency improvements with the need to maintain an acceptable level of fairness to all customers.

On the supply side, priority is to be given to maintaining and improving the performance of the existing system because it will meet the bulk of electricity needs for decades to come. Economic hydroelectric generation is to be pursued in an orderly program and initiatives in this area are already underway. When major supply is required, the lowest cost supply or purchase options available to meet the need will be chosen, based on evaluation of the most up-to-date information available at that time. Such evaluation will also require judgmental assessment of environmental and social effects of adopting different options. The strategy proposes appropriate activities in the alternative generation, nuclear and fossil areas to maintain a technological base that will keep options open for future use if required.

DRAFT DEMAND/SUPPLY PLANNING STRATEGY

CONTENTS

1.0 INTRODUCTION

This report and its supporting documents describe the studies and considerations that have led to a Draft Demand/Supply Planning Strategy. These studies have been underway since 1984 and are known as the Demand/Supply Options Study or the Meeting Future Energy Needs Study. This draft strategy was accepted by the Ontario Hydro Board of Directors at their November 16, 1987 meeting as a reasonable basis for public review and discussion on the strategic directions Ontario Hydro should follow. The purpose of issuing this draft is to provide a focus for public discussion; a review process without a proposal on the table would lack direction and might not address the significant issues. This draft strategy may well be changed as a result of the review process before a strategy is adopted by the Board.

Demand/Supply planning is concerned with the planning of the electrical system to provide a balance between electricity generation and electricity demand so that needs for electricity service are met reliably and economically. This process is an extension of the generation planning process. It is clearly recognized that a utility can assist customers to use less electricity to reduce the need for new generating plants.

This planning process is dynamic as the inputs are continuously evolving. For example, as more information on economic growth and load growth becomes available, forecasts are adjusted and appropriate changes must be made to plans. Plans are regularly updated based on the latest information, usually once a year.

Demand and Supply planning must look a long way into the future. While plans focus on the decisions that are required in the next five years, these decisions affect options that will become effective within the next 20 years and will operate for a useful life of up to 90 years. The decisions made in the next five years will affect system operation for many decades.

Although plans are continuously evolving, it is necessary to have a constant set of strategic objectives and priorities to guide the planning process. These strategies should be fixed over a long period of time so that development moves consistently towards meeting the long term needs. The Demand/Supply Planning Strategy is this set of strategic objectives and priorities. Drastic changes in the economic and energy environment may require the strategy to be revised.

The strategy should not specify the quantities of individual options - that is a degree of detail that is only appropriate for plans. In addition if a strategy is too specific in areas that are subject to change it will not be durable. The strategy must be focused on criteria which will help in the selection of options. It must provide guidance in areas of general policy many of which are difficult to subject to quantitative analysis but can have large impacts on the directions that are followed.

Ontario Hydro has not had a strategy with this name before and the question may be asked 'why do we need one now?' In the past there have been policies and strategies that dealt with many of the subjects that are addressed in the Demand/Supply Planning Strategy. However, now is an appropriate time to reexamine these issues and produce a coordinated strategy because planning is at a significant turning point. For the last seven years generation planning has been mostly concerned with slowing down or cancelling construction plans for new generating plant. Construction programs were started in the 1970s to meet forecast levels of load that did not fully materialize. Consequently a period of adjustment was required. However, there have now been more than four years of strong growth and the need for new demand or supply options is only about ten years away. While this may seem a long time to many people compared to their personal or business planning horizons, this is not a long time to develop new generating plants or new demand management programs. It is important that the strategies for the further development of the system be put in place now so that the preparation of detailed plans, approval processes, etc. can proceed in an orderly and timely manner.

Public consultation is a part of the planning process. Ontario Hydro has undertaken extensive public consultation in the preparation of plans for major transmission lines. This report forms part of an intensified program of public review of demand/supply strategies. Public processes will continue as specific plans and projects are proposed. However, a balance must be maintained between the need for public consultation and the need for timely decision making. There is a danger throughout North America of a form of paralysis where needed projects that are beneficial to the majority of people can be held up indefinitely in approval processes by a small minority. The result may well be dislocation to the economy and new programs and projects that are too little and too late. Ontario Hydro remains committed to timely public consultation, review and approval processes.

The various sections of this report describe the general considerations and the lessons learned from analysis that led to the Draft Demand/Supply Planning Strategy. Chapter 2 shows how planning can help to shape the future including an outline of Ontario Hydro's planning process. The general Ontario energy situation is discussed in Chapter 3 so that planning for electricity service can be viewed in a broad energy perspective. This chapter also discusses the concept of resource conservation. Chapter 4 introduces the forecast of electricity needs while Chapter 5 indicates the capabilities of the existing system. Chapter 6 compares the forecast of electricity needs with the capability of the existing system to show the requirement for new resources. Chapter 7 examines the economic and other criteria used to evaluate plans and options. The characteristics of the options that are available are briefly summarized in Chapter 8 based on analysis described in the Supplementary Report "The Options" and other reference reports. Chapter 9 summarizes the results of a number of public consultation programs which are more fully described in the Supplementary Document "Public & Government Consultation" and a series of reference

reports. A number of representative plans have been analyzed. This analysis is summarized in the Supplementary Document "The Analysis of Representative Plans" and a series of reference reports. Chapter 10 gives the main conclusions from the analysis of representative plans that are relevant to the foundation of demand/supply planning strategies. The rationale for the strategy is given in Chapter 11 and the strategy is summarized in Chapter 12. A number of terms which are used throughout the report are defined in Chapter 13. Chapter 14 lists the supplementary and reference documents and indicates which chapters of this report they support. The supplementary documents are available as a companion volume to this report. Throughout the report and the supplementary documents are references to a large number of other documents. These are all available to the public either on request or in the Ontario Hydro Public Reference Centre at 700 University Avenue, Toronto.

This draft report is the result of an extensive and comprehensive study process which began in 1984 to assess all the options available to Ontario Hydro in meeting the electrical power needs of the province for the next 20 or so years. The first phase of the study, completed in 1985, was to identify and characterize all feasible electricity supply and demand options. In Phase 2, completed in 1987, various illustrative plans involving combinations of the options were developed and evaluated and the draft Demand/Supply Planning Strategy described in Chapters 11 and 12 was formulated.

The evolving nature of the studies and associated results over such a long time period makes it virtually impossible to have every part of the study based on the latest data available. However, care has been taken to ensure that independent portions of the studies, such as the comparison of options and the evaluations of illustrative plans, are based on a consistent set of data and assumptions in each case. Also there has been reasonable stability in recent years regarding energy and economic data and forecasts and thus the conclusions and proposed strategy items would not be significantly changed by redoing any of the studies with the most recent data. Comments on the extent and effects of any changes in data are made where appropriate.

2.0 SHAPING THE FUTURE

This chapter discusses the concepts and process for planning in general and this study in particular. It includes a discussion of planning in Ontario Hydro, including the mission and values that define our responsibilities as a public corporation. There is a general discussion of the reasons why more demand/supply resources may be needed. The process is described by which plans evolve based on updated forecasts, technical studies and public input. The decisions to implement specific options are subject to internal and external review.

2.1 The Conceptual Basis for Planning

People, organizations, and countries plan to better prepare for the future. If they do not plan, then events will dictate what is or is not possible.

The question is often asked: But how can you plan if you cannot accurately forecast the future? We recognize that we cannot accurately foretell the future, so we must plan for a number of possible futures. A key to good planning is flexibility to adjust to changing circumstances.

Plans evolve. They are updated continuously as our knowledge of our surroundings changes. This means the further back one makes commitments the more off target one will likely be. The reverse is also true; better decisions can be made as one gets closer to the time of need.

The choices we make are shaped and constrained by our resources, geography and values. We plan to do things that are within our means and that are acceptable to society. They must be technologically and commercially viable and environmentally acceptable. The things we plan must be ethically acceptable to society.

2.2 The Nature of Planning in a Public Electric Power Utility

Planning is particularly crucial in a business that is capital intensive and requires long periods to develop new resources, which in turn can last for 30 to 40 years or longer. Shortages or surpluses could result in considerable additional costs and can take a long time to correct.

We are expected to provide electricity on demand throughout Ontario. This dictates responsibilities and constraints that may not exist for other large corporations.

Another factor that shapes the nature of planning in Hydro is its public ownership. Ontario Hydro's shareholders are our customers so our primary concern is to maximize the benefits to our customers. Ontario Hydro's revenue requirement depends on its costs. Increased costs to the corporation become increased costs to customers.

Because Hydro touches the lives of everyone in the Province, the public must be given an opportunity to participate. The planning process therefore must be open and comprehensive. We must solicit the publics' opinions so that it may influence the planning process in the most timely and effective way possible.

The public ownership, the stability of the business and the long periods needed to develop new resources make it appropriate and necessary to take a long term rather than a short term view. Our past practice of taking the long term view has resulted in today's reasonable rates and good service.

In our planning, we have historically emphasized customer satisfaction, cost effectiveness, safe operation and environmental responsibility. Now, because many of our existing stations are reaching the end of their useful life, we must also consider the development of new resources to replace this old equipment.

We must ensure that we devote all of our efforts toward fulfilling our obligations under the Power Corporation Act and as a public corporation. To this end, we have codified these responsibilities in the following statement of our mission and values.

MISSION

Our continuing purpose at Ontario Hydro is to contribute to the enhancement of the quality of life of the people of Ontario by serving their energy needs:

- Electricity is essential to our quality of daily life and to the continued prosperity of the people of Ontario.

- Ontario Hydro will meet this need reliably, economically and with sensitivity.

- We will continue to bring competent people and appropriate technology to bear on the supply, use and conservation of electricity.

- We will use our special knowledge, skills, facilities and by-products for the benefit of our customers and the people of Ontario.

VALUES

To accomplish our mission:

- **We are committed to customer satisfaction.** This commitment is the single most important value upon which daily decision-making at all levels within Ontario Hydro is based.

- **We are committed to flexibility.** We must be prepared to meet the challenges arising out of unpredictable economic and technological occurrences.

- **We are committed to reasonable pricing.** We recognize that economic forces affect our customers, and therefore we must keep electricity prices competitive.

- **We are committed to responsiveness as a public corporation.** We shall operate the corporation so as to make the citizens of the province proud of it.

- **We are committed to a fundamental respect for each other as employees of Ontario Hydro.** People are our most important resource. We recognize the competence of our people, give them freedom to operate and hold them accountable for results.

2.3 Focus of Demand/Supply Planning

There are a number of reasons why new resources would be required (Figure 2-1). This section describes the indicators that we focus on at Ontario Hydro.

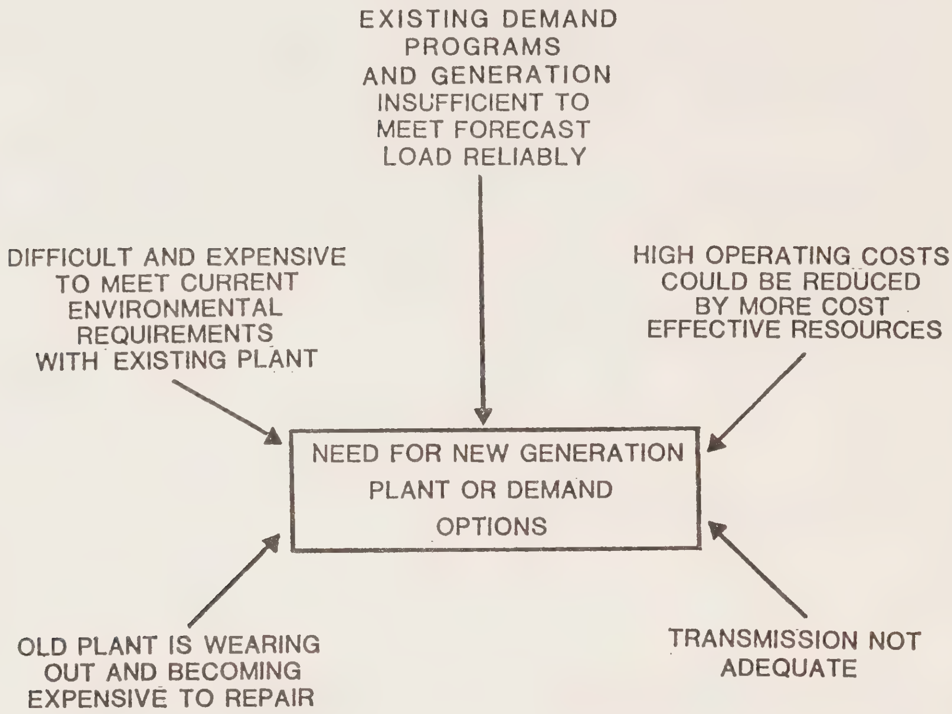
2.3.1 To Meet Customer Demand Reliably

The expected demand for electricity is the most significant factor influencing the requirements for additional demand/supply resources.

Electricity must be instantaneously produced as it is consumed because it cannot economically be stored in large quantities. Therefore, to maintain a high standard of service, there must be enough generating capacity available to supply the highest demand during the year. Without action, this peak demand will probably grow until it exceeds the capacity of the existing generating system. We can either pursue demand options to keep this demand down or we can build generating stations to keep ahead of demand.

FIGURE 2.1

NEW FACILITIES ARE REQUIRED FOR SEVERAL REASONS



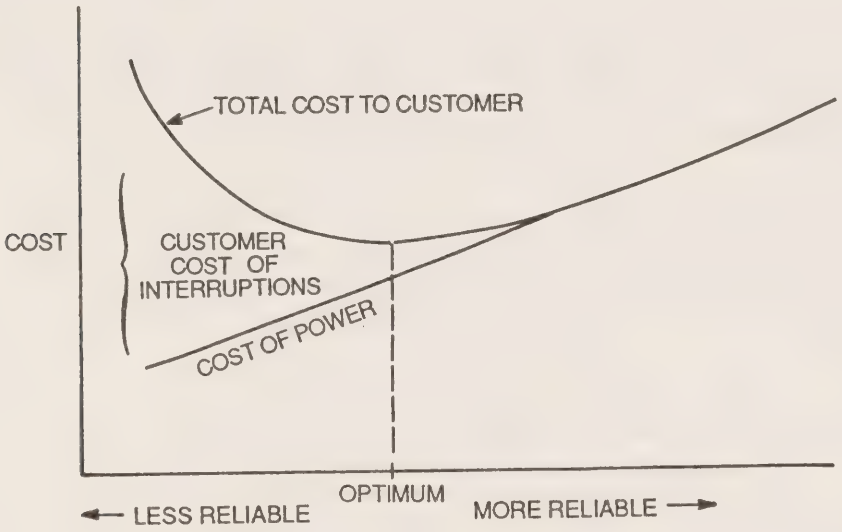
Actually, the planned generating capacity must be significantly higher than the expected peak power demand because allowance must be made for the following factors:

- normal minor equipment breakdowns;
- occasional major repairs and maintenance;
- operating constraints due to local air quality considerations, water levels and flows, transmission considerations, coal freezing, etc;
- load in excess of that expected owing to unseasonably cold or hot weather, unexpected economic growth, etc.
- labour strikes affecting fuel supply, transportation, etc; and
- delays to the in-service dates for new generation and transmission facilities.

For capacity planning, all electric utilities use a generating capacity reserve in addition to the forecast peak demand. The selection of reserve level must balance the higher costs of the power system if the reliability is too high against the higher costs of interruptions to customers if the reliability is too low (Figure 2.2). The System Expansion Program Reassessment Study in the late 1970's included customer surveys to estimate the cost of interruptions to customers and estimates of power system costs with different levels of reliability. This led to the development of a

generation planning reliability standard for Ontario Hydro (Reliability Criterion for Generation Planning, Report 603 SP, 1981) which aims to achieve the lowest total cost to customers. The reliability criterion is stated in terms of the degree of expected interruptions to customers due to shortages of generation. The amount of reserve generating capacity required to meet this standard depends on the expected reliability of each generating unit, the system size and the way in which the electrical load varies through the year. At present, it is estimated that the installed generating capacity should be about 24% above the load which must be supplied reliably. This reserve is estimated to provide adequate protection to deal effectively with the factors indicated above.

FIGURE 2.2



LEVEL OF RELIABILITY

2.3.2 To Reduce Costs

In addition to providing the customer with a reliable supply of electricity, we strive to provide electricity at the lowest cost to the customer over the long term. Opportunities to reduce costs to customers will affect the timing and types of demand and supply options selected. In some cases, generation installed to reduce costs may result in surplus capacity above the required reserve level. For example, in some systems in the U.S. and elsewhere, it has been economic to implement demand management programs or to build a new coal or nuclear plant to reduce the use of oil-fuelled plants.

Opportunities to reduce costs also arise when adjusting plans to respond to reductions in the forecast rate of load growth. It may be economic to reduce demand through more efficient use, or to complete a generating plant with low operating cost and temporarily reduce the use of existing, higher operating cost plant. An analogy here would be the person who puts a lot of miles on his old V-8 car. He's paid for the car, but he gets large bills every time he drives up to the gas pump or into the repair shop. This person may find it more economical to take on payments for a new fuel-efficient car to reduce his high gasoline and repair bills.

2.3.3 To Meet Evolving Environmental Standards and Regulations

Meeting environmental regulations also affects the choice and timing of resources. All new generating facilities must be built to be environmentally acceptable. All existing facilities must be operated, with modifications if necessary, to meet environmental regulations. These regulations may be more stringent than those applicable when the facilities were planned.

An example of need for new resources to meet evolving environmental requirements is the need to reduce acid gas emissions from coal-fired stations. The alternatives are demand management programs, to reduce the amount of coal-fuelled generation needed, new generating stations which burn cleaner fuels, or the installation of scrubbers.

The costs of meeting environmental regulations are included when determining the most economic alternative. Remaining environmental impacts are considered along with costs and other factors in the approval process.

2.3.4 To Replace Aging Facilities

New resources are required to replace old, worn out generation that is uneconomic to maintain or rejuvenate, independent of the growth in demand. A reduction in demand through demand management programs would be one alternative to replace this generation.

2.3.5 To Compensate for Transmission Limitations

A transmission system that does not fully integrate the generating resources of an electric utility will necessitate more generation to meet demand. This is due to limitations in getting the power from where it is generated to where it is needed. An example of that is Ontario's northwest, which was initially separate from the rest of the system. Now it is linked with transmission, but the link is still not strong enough for it to be fully integrated. This means that generation is required locally to reliably supply customer demand.

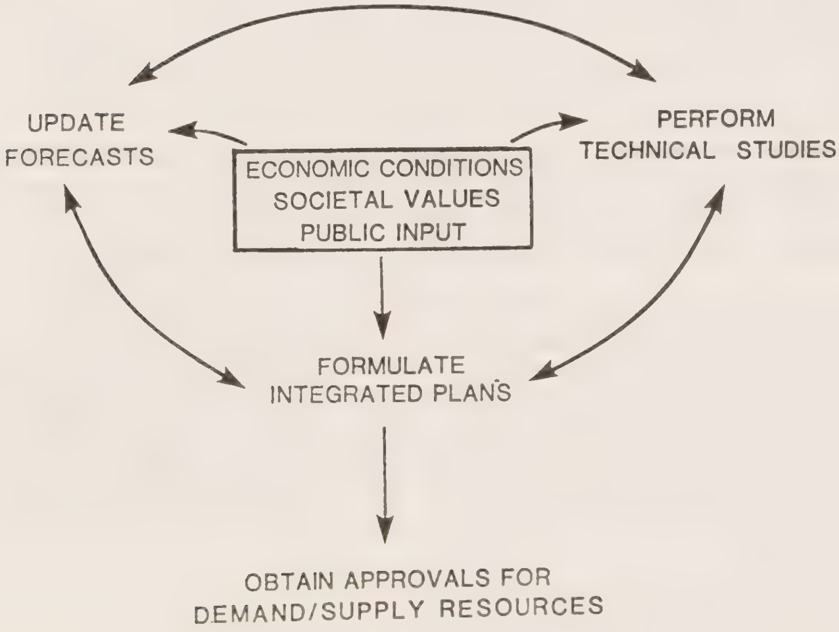
2.4 The Planning Process In Ontario Hydro

Forecasts of the future demand for electricity are always changing as better information becomes available. Plans must be adjusted continuously to account for these changes. Hydro also makes decisions regularly to proceed or to hold off on projects.

This section describes our planning process in Ontario Hydro. It illustrates the ever changing and comprehensive nature of the process. The process (Figure 2.3) will be described under five major headings: Forecasting, Studies, Integration, Public Input, and Approvals.

FIGURE 2.3

THE PLANNING PROCESS IN ONTARIO HYDRO IS A CONTINUOUS ONE



2.4.1 Forecasting

Forecasting future conditions in the Province is an ongoing activity within governments, corporations and independent think tanks. It is the way a corporation like Ontario Hydro looks down the road to get an idea of what is ahead. We usually get a clear idea of what is expected next year, less clear an idea about five years from now and only a fuzzy picture for 15 years from now. Because new resources take five to 15 years to implement plans must be based on a comparatively uncertain forecast. To deal with this uncertainty, upper demand and lower demand projections are prepared. We prepare corresponding contingency plans to assist us with adjusting our actions in response to a wide range of future conditions.

The forecasting exercise considers a large number of factors such as population, economic, technological, social and energy use trends. The many considerations surrounding this process are discussed in Chapter 4.

2.4.2 Technical Studies

Another activity in planning is to review our ability to serve customers into the future. We continually reassess the capability of our system to provide an adequate and reliable supply of electricity to the people of Ontario. Chapter 5 of this report is a snapshot assessment of our capability to serve customers into the future.

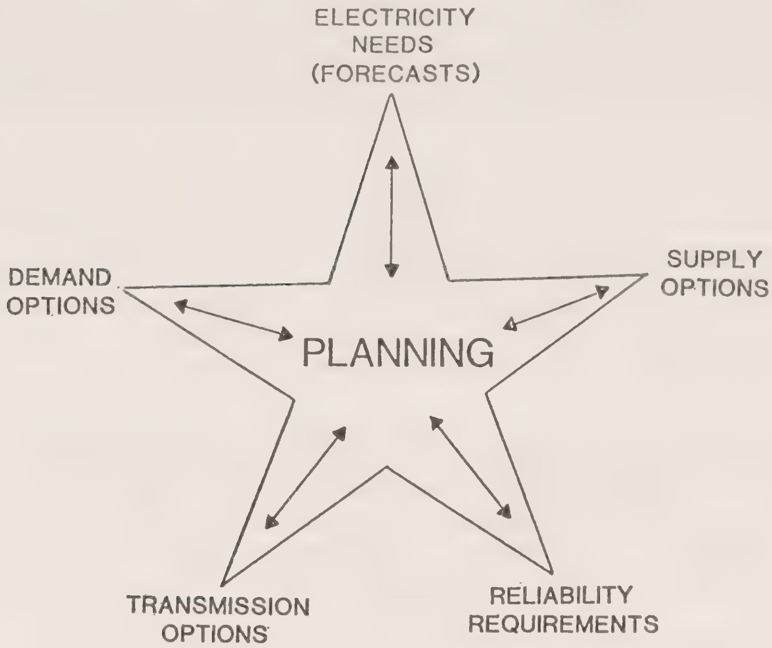
The existing facilities cannot supply projected future needs indefinitely. A parallel activity is identifying potential new resources. These resources may include programs to assist customers to use electricity more efficiently, or plans to increase or decrease the supply.

2.4.3 Formulating Integrated Alternative Plans

We create several alternative system plans after future needs are identified and after a wide range of data has been assembled. This data includes cost data; macro-scale environmental and social impact data; customer preferences and values; and technical data relating to the relative capabilities of the various possible options. The integration of the various options is a significant attribute of plans as they must ensure that various parts of the electricity system are working well together (Figure 2.4).

Ideally, one system plan would emerge from all the analysis as technically the best, most cost-effective and having least environmental and social impacts. Usually, more than one of the alternative plans will be technically acceptable. Trade-offs among cost-effectiveness, environmental impact and social benefits, will exist. Technically acceptable alternative plans will be retained as potential plans. While these plans continue

FIGURE 2.4
INTEGRATED PLANNING
ENSURES THAT MANY ASPECTS
ARE CONSIDERED



to be updated and studied, another process starts. Public input is sought to assist us in further refining the plans and their implications.

2.4.4 Obtaining Public Input

Ontario Hydro has, for many years, recognized its responsibility to inform and consult with the people potentially affected by its plans and activities. Our consultation and communications programs have two overall objectives:

- to inform the people of the province of the need for long-term planning and the range of options available to meet future energy needs;

- to obtain the views and advice of a wide cross-section of people on the options and the planning process.

Public input helps to ensure the plans we develop to meet our customers' needs for electricity in the future reflect the needs, values and expectations of the Ontario community. We must seek public input after sufficient details are available to make this input meaningful and early enough so that this input may be effective. Chapter 9 discusses the public consultation programs associated with the formulation of this Demand/Supply Planning Strategy.

2.4.5 Obtaining Approvals

As the time when we need new resources approaches, decisions as to whether to proceed to acquire these resources are made. The decisions are made in the context of a strategy that has been adopted. The commitment to begin demand management programs or supply facilities requires several stages of review and approval both within Ontario Hydro and externally.

Internal Approvals

System plans and proposed projects are reviewed by many levels of staff, internal committees and line managers up to the President. For large capital investments or planning policy decisions, public input is sought and approval of the Board of Directors is required.

External Approvals

Once internal approvals have been given, review and approval of Ontario Hydro's plans for additional supply facilities is then sought under the Environmental Assessment Act or the Consolidated Hearings Act. The provincial government or the Ontario Energy Board may review plans for demand management. In addition, depending on the nature of the project, reviews and approvals may be required from other public bodies such as:

- Atomic Energy Control Board;
- National Energy Board;
- Royal Commissions; and
- Select Committees of the Ontario Legislature.

In addition to the Environmental Assessment Act and the Consolidated Hearings Act, Ontario Hydro's plans and projects are also subject to some of the following acts:

- The Power Corporation Act;
- The Planning Act;
- The Niagara Escarpment Planning and Development Act;
- The Environmental Protection Act;
- The Ontario Water Resources Act;
- Regional Government Acts; and
- Expropriation Act.

Approvals under many of the above acts are granted by the Ontario Cabinet.

Finally, before construction can start or any order can be placed, the Government of Ontario must approve by issuing an Order-in-Council. Government approval is also required before we can raise additional capital by selling bonds.

2.4.6 <u>Time to Complete the Planning & Approval Process</u>

The various steps described in the above sections all require time to complete and generally all must be done in sequence, the outcome of each step being required to proceed with the next step. For the typical large demand management programs or supply projects at Ontario Hydro, the total elapsed time for this process is in the range of five to eight years. This must be added to the implementation time for new demand management programs or the construction time for new supply facilities to obtain the total planning lead time to be allowed for in deciding on the time to initiate the planning process to meet a forecast need.

Since 1983, Ontario has experienced significant economic growth accompanied by the largest electricity growth in the history of Ontario Hydro. This growth, together with the long lead times as noted above, indicates the need for urgency in the development, review and approval of the Demand/Supply Planning Strategy.

Shortening the lead times for the planning, approvals and construction of new demand/supply resources will generally permit better and more timely decisions to be made and the risks to be reduced. Conversely, longer times or delays in these processes will introduce higher risks involving costly penalties. For example, the unforeseen lengthy delays in the approval process for the Southwestern Ontario Transmission Expansion is estimated to carry a cost penalty of $400 million. The major item in this penalty is the higher cost coal-fuelled energy required to replace the nuclear energy 'locked in' at the Bruce generating complex up to the currently scheduled in-service date for the new 500 kV transmission line from Bruce to London. In addition, the penalty includes the costs for installing stop-gap facilities in the form of special protection schemes to maximize the utilization of existing transmission facilities. It does not include any additional costs incurred or which may yet be incurred in operating a system having a less than desirable level of reliability.

In view of the significant potential for improving decision making, reducing cost penalties and increasing planning flexibility, Ontario Hydro is pursuing initiatives to improve the planning and approval process.

3.0 ONTARIO ENERGY SITUATION

The availability of adequate sources of energy of all forms is essential to the success of our society and to its further growth. Understanding and appreciating the wider energy picture, the factors that influence the demand for energy and the energy sources we use, provides a foundation for electric supply and demand planning. This broad energy perspective is intended to assist electricity planners in ensuring that energy resources are not wasted and that the right energy sources are used for the right jobs.

3.1 Ontario Energy Demand

Ontario is the industrial heartland of Canada. The majority of Canadian manufacturing companies are located here as are many energy-intensive resource industries. Large distances between major urban centres and harsh weather are some of the additional reasons why Ontarians are among the highest users of energy in the world. If we are to continue to maintain a balance between the future demand for energy in Ontario and energy supply, we must understand what influences this demand and how the energy pie is divided among the primary sources available to us.

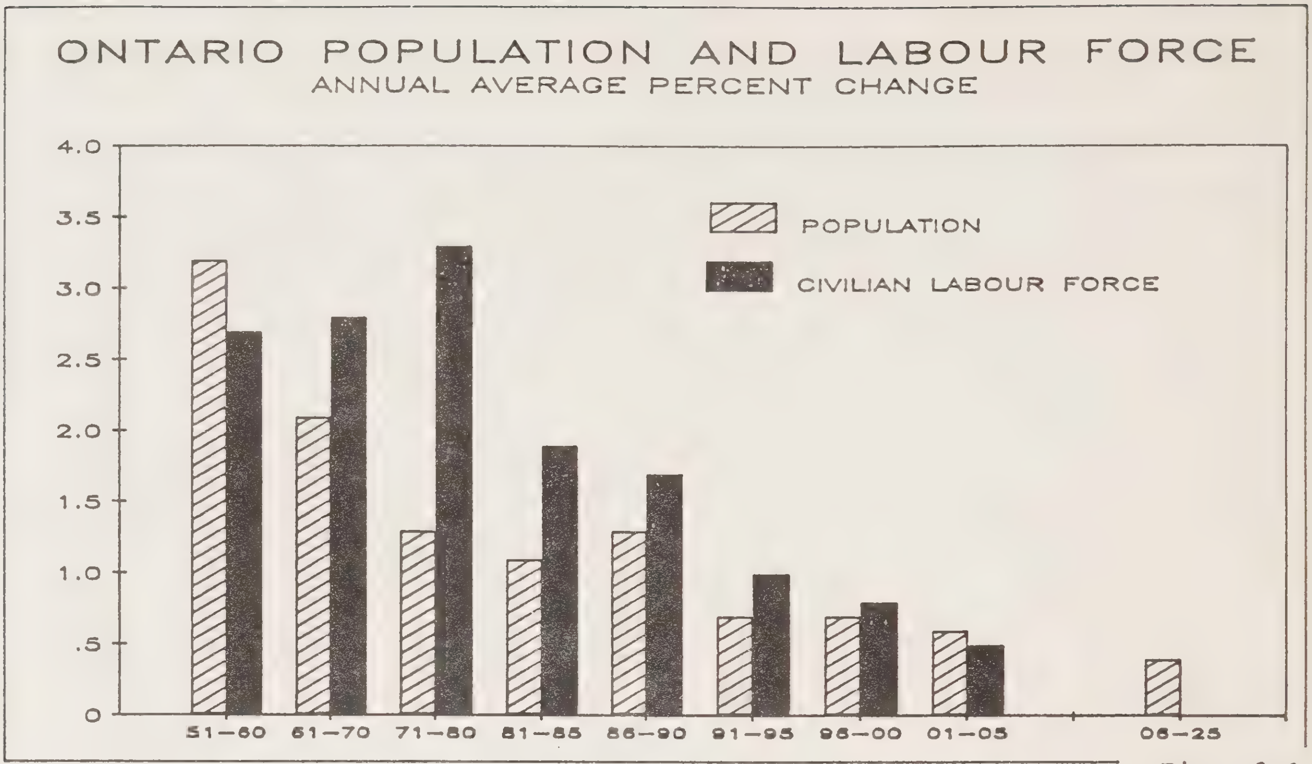
3.1.1 Population

The total size of the population of Ontario is the major factor influencing the demand for energy. Not only do people use energy directly to provide themselves with the basic creature comforts, but the whole economic system centres around the provision of products which ultimately serve human needs. Forecasts of the size of the population are, therefore, fundamental to forecasting changes in the economy and the demand for energy.

In addition to forecasting how many people will live in Ontario in the future, it is also essential to understand any changes in the age and sex distribution of the population. This demographic profile affects the size of the work force, the size and income of households, consumption patterns and many other social and economic variables.

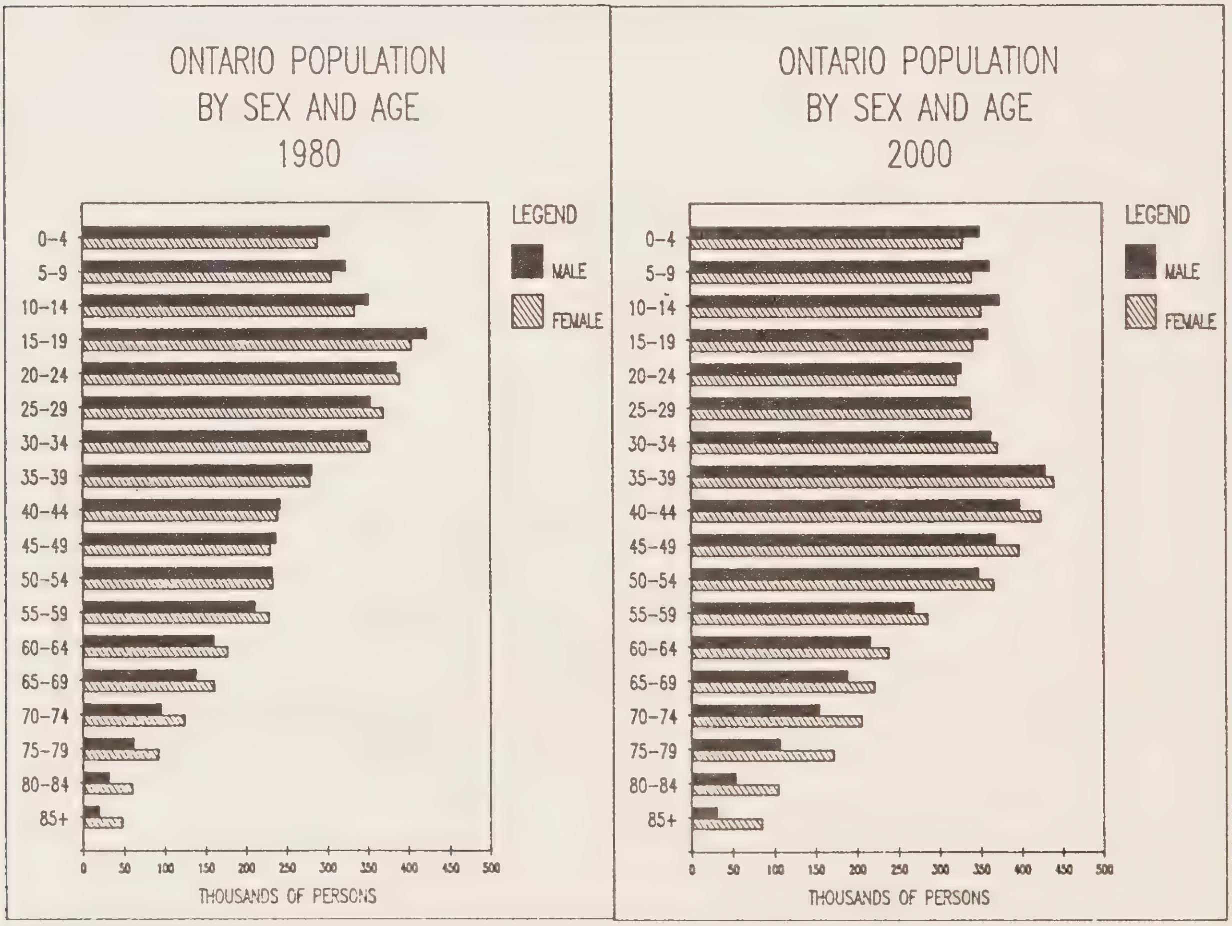
Population increases have slowed considerably, (Figure 3.1). After reaching a high of 3.8 in 1960, the average number of children born to an Ontario woman during her lifetime (fertility rate) set on a long-term decline. Only in the last few years have there been signs that a turnaround might be in sight. Current projections are that Ontario's total fertility rate will increase gradually through the rest of this century.

Because of high unemployment, the federal government had in the past tightened restrictions on immigration. However, unemployment has been falling and there are shortages of skilled workers in certain areas. Therefore, the longer term projection assumes an increase in the number of immigrants per year. (See Reference Document: Long-Term Economic Outlook).



ONTARIO POPULATION AND LABOUR FORCE
ANNUAL AVERAGE PERCENT CHANGE
POPULATION
CIVILIAN LABOUR FORCE
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
51-60
61-70
71-80
81-85
86-90
91-95
96-00
01-05
06-25

Fig. 3.1



ONTARIO POPULATION BY SEX AND AGE 1980
ONTARIO POPULATION BY SEX AND AGE 2000
LEGEND
MALE
FEMALE
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85+
0 50 100 150 200 250 300 350 400 450 500
THOUSANDS OF PERSONS

Fig. 3.2

Internal migration also looks favourable for Ontario, due to the performance of the provincial economy relative to other provinces. This trend is likely to continue at least in the near term.

All in all, current forecasts indicate that, by the turn of the century, Ontario's population will be just above the ten million mark, and the growth rate will be about 0.7% per year.

Canada's population is not only growing more slowly, but getting older as well (Figure 3.2). A direct result of population aging will be a shift of society's resources toward the support of the elderly.

The labour force experienced rapid growth over the decade of the 1970s. However, the major impact of the baby-boom generation on labour force growth is over. In future decades, declining population growth and aging will dramatically reduce growth of the working age population. Ontario's labour force growth rate is expected to decrease from the average annual rate of 3.2% in the 1970s to 0.7% in 2000. Indeed, the labour force growth rate is eventually projected to lag behind the population growth rate as the baby-boomers retire.

3.1.2 <u>Economy</u>

The long-term potential of an economy is determined by the growth rate of the factors of production (labour, capital and natural resources) and the growth rate of the productivity of these factors. The real gross provincial product (GPP) is used to measure the level of economic activity. While in absolute sense the GPP is forecast to grow from $59 billion in 1985 to $92 billion in the year 2000 (expressed in 1971 dollars), the rate of growth over this period is slowing down.

Demographic factors are the dominant cause of the slowdown, initially because low birth rates are beginning to affect labour force growth; but towards the end of the forecast period the retirement of the baby-boom generation becomes the dominant factor. As well, the rise in the number of women seeking jobs is expected to taper off.

In the 1970s there was a decline in the rate of growth of productivity. While the explanations for this decline varied widely, there is a general agreement that the phenomenon was not caused by a single factor; rather, several factors were likely responsible. The productivity slowdown occurred at a time of severe energy price shocks, runaway inflation and a demographic bulge.

Looking ahead, productivity growth in the 1980s and beyond should be much better than it was in the 1970s, if for no other reason than a mere return to a more stable and familiar environment. First, the slowdown in labour force growth is expected to lead to higher productivity because it will allow more capital equipment for each worker. Second, conservation efforts, together with augmented supplies from non-member countries, have seriously eroded the power of OPEC to set prices of oil. Third, inflationary

pressures have subsided. While it may be shortsighted to read too much into the current low inflation rates, the events of the past three years are demonstrative of the commitment of U.S. and Canadian authorities to keep inflation under control.

3.1.3 Primary Energy Demand

In general, energy use varies with economic activity and prosperity. However, there are differences in energy use among countries having equal levels of economic activity. These are partly due to the efficiency with which energy is used. While increases in energy use associated with improved economic well being may be desirable they should be accompanied by continuous emphasis on reduction in inefficient energy use.

In this context we talk about primary energy in its raw, unprocessed form - coal from mines, uranium from mines, crude oil and natural gas from wells or falling water in rivers (Figure 3.3). This primary energy is in turn processed by energy industries, such as petroleum refineries or electricity generating plants, to different forms demanded by consumers. Over a third of all these resources were used to produce electricity. This emphasizes the significance of electricity in the well-being of the province.

With the expansion of the economy of Ontario the need for energy has been steadily growing but the use of energy has not kept pace with the growth of the economy. This can be illustrated (Figure 3.4) by observing the amount of energy used to produce a dollar of output in Ontario (measured by the gross provincial product). The downward trend of the energy graph indicates that we, as a society, have become more conserving and energy conscious over the last dozen years. In contrast to the decreasing use of total energy, the amount of electricity used for each dollar of output in Ontario has been increasing over most of the period. This is an indication that electricity has been becoming an increasingly more popular source of energy because of its many inherent features such as flexibility, cleanliness and efficiency. However, over the last few years, the electricity use per dollar of output has become flat and is projected to slowly decline in the future as the growing commitment of our society to improved efficiency begins to show effect.

3.2 Ontario Energy Resources

The Province of Ontario has an abundance of valuable natural resources, but it is not self-sufficient in its primary sources of energy. The security of supply and local control of pricing that are associated with the use of resources indigenous to Ontario are potential benefits to Ontario Hydro's customers. In addition, the provincial government favours the development of local resources to provide employment and stimulate the provincial economy. Currently over two thirds of Ontario's primary energy is imported and consequently their prices and availability are controlled outside the province. This introduces a considerable level of uncertainty into the process of planning ways to meet Ontario's future energy needs. It is, therefore, essential to understand the present as well as the expected primary energy resource options open to Ontario.

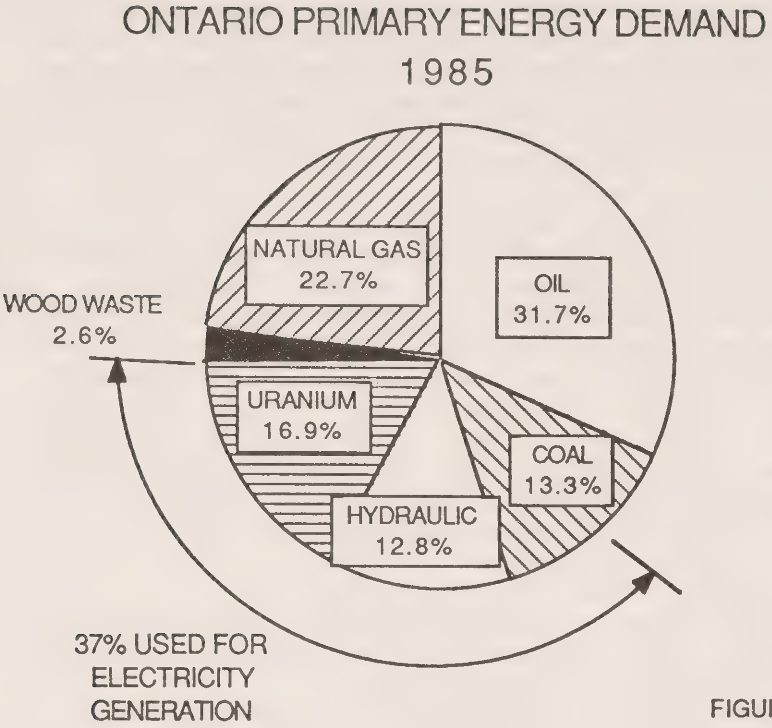


FIGURE 3-3

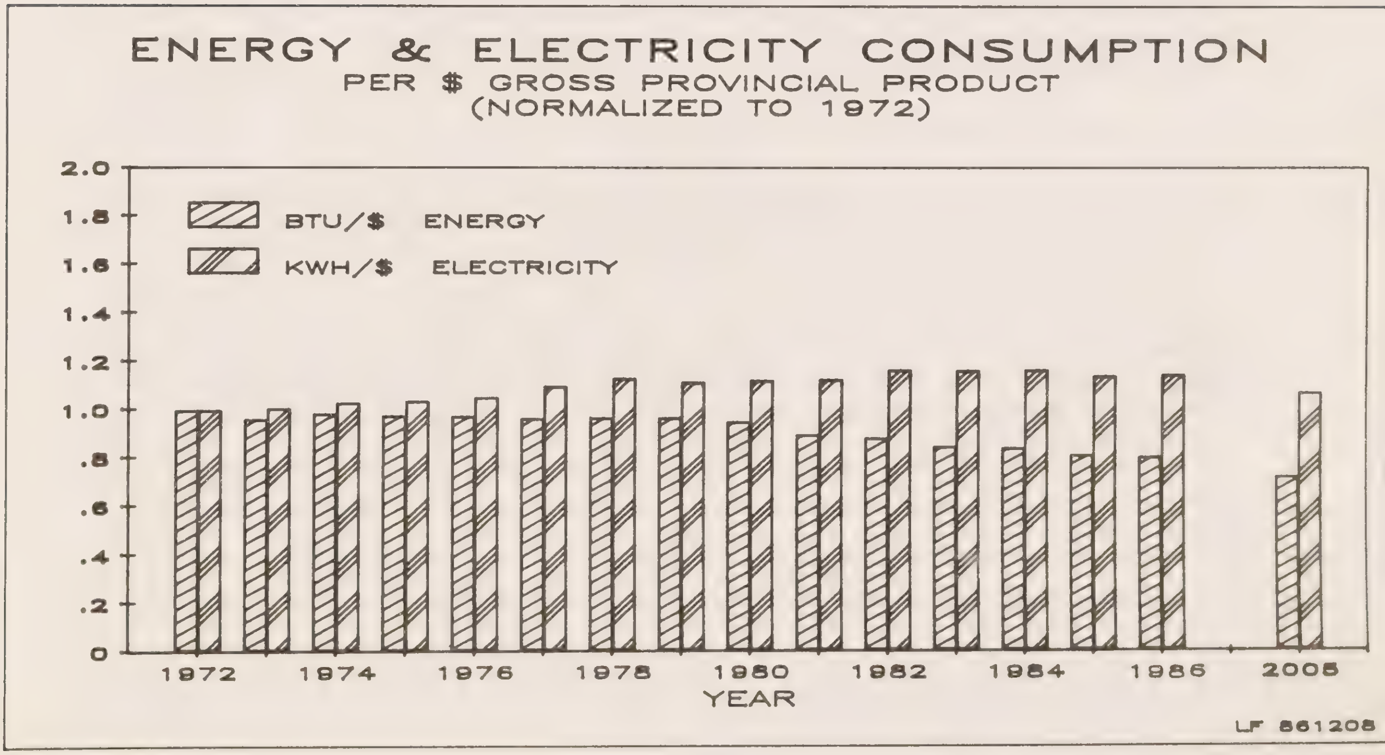


Fig. 3.4

One of the most comprehensive studies of energy resource supply and use was undertaken in 1985 by the Ontario Ministry of Energy under the title Energy 2000. It provides detailed analyses of the availability of energy resources. The availability of resources will have a major impact on the planning process of Ontario Hydro.

3.2.1 Crude Oil

Crude oil supplies the largest single portion of Ontario's primary energy needs and most of it must be imported from outside the province. Ontario's annual production is only equivalent to one day's consumption. As a major purchaser of oil, mainly from western Canada, Ontario is therefore extremely sensitive to the Canadian oil market behaviour which is heavily influenced by the world market for oil. The dramatic developments in this market that started in late 1985 are expected to ease pressure on prices in the short run but, at the same time, increase the probability of price increases in the long run. The long-term supply of oil is limited. Despite the current short-term oversupply of oil, the world's known reserves of low cost oil are being depleted.

Maintaining self-sufficiency in oil is expected to remain a strategic objective for the government of Canada in order to reduce vulnerability to any future supply disruptions. Enhanced recovery, synthetic crude oil, crude bitumen from oil sands deposits, heavy oil and frontier oil are forecasted to be required to balance projected demand in the early 1990s. However, these unconventional sources cost much more than current world oil prices, and there is a growing fear in the oil industry that without government intervention most of them will be delayed, some indefinitely. In the 1990s, increasing demand, declining availability of non-OPEC oil and the resurgence of OPEC's market power are expected to again put upward pressure on oil prices.

3.2.2 Natural Gas

Natural gas is rapidly increasing its share of the Ontario energy market, almost entirely at the expense of oil. In 1985, almost a quarter of all primary energy used in the province came in the form of natural gas.

Even though Ontario produces only a small fraction of its annual natural gas consumption, the dependence on out-of-province imports is limited to Western Canada. While the Canadian gas market has experienced some volatility recently, it has been more stable than the world oil market. In the long run, natural gas prices in Canada are expected to be strongly influenced by U.S. prices and the North American supply/demand balance for conventional (lower cost) gas.

Currently, due to a surplus in the U.S., and very low oil prices, natural gas prices in the U.S. have been depressed below the average finding costs. Despite the surplus, the adequacy of future production and recoverable sources of natural gas in Canada and the U.S. is highly uncertain. Additions to known reserves (ie new wells) and development of frontier sources will be critical for future natural gas supply, both in Canada and the U.S. These new reserves, however, will be more expensive than conventional gas reserves, and natural gas prices are expected to be again under strong upward pressure in the 1990s.

Per unit of heat content, natural gas is currently the least expensive fuel in all sectors of the Ontario economy and is expected to remain so for the next ten to 15 years.

3.2.3 Electricity

Electricity is a manufactured form of energy, not a primary energy resource in itself. Since on one hand very little oil and natural gas is used in electricity generation, and on the other hand the energy from uranium, falling water and for the most part, coal can only be conveniently used if converted to electricity, electricity can be considered as a resource alternative to oil and gas.

By 1993 committed electricity production capacity in Ontario will consist of 43% nuclear, 29% coal, 20% hydraulic and 8% oil and gas generation. Due to their low operating costs and design characteristics, nuclear plants provide most of the electricity needed on an on-going basis - the base load - while fossil fuelled plants supply the extra power needed during peak demand periods. Hydraulic generation plays both of these roles as dictated by individual river and plant characteristics. Hydraulic generation purchased from neighbouring provinces has also made a significant contribution to electricity supply. Purchases have been made under a variety of contractural arrangements when mutually acceptable terms could be negotiated.

Large scale hydraulic generation has provided inexpensive electricity to Ontario for over seventy-five years. The future expansion potential for this option is, however, limited as the number and water capacity of undeveloped rivers is finite. While water used in hydraulic plants is a renewable and indigeneous resource available at low cost, not all potential capacity can be developed. Because most conveniently available sites have already been used, new plant sites are being identified only in increasingly more remote areas; the potential economic, environmental and social costs begin to make their construction unattractive.

When Ontario's industrial development created a need for electricity which exceeded the ability of the hydraulic generating plants, coal-fired stations were built. Today, coal-fired electricity generation uses a proven technology, readily available in Ontario. While the basic technology is well developed, the technology to control environmental emissions is still evolving. This option has provided a reliable source of electricity throughout the period of rapid growth of the Ontario economy in the 1960s and 1970s.

The damage to the environment from acid rain, which can be caused by the acid gas emissions from coal fired power plants, has sparked initiatives to reduce these emissions. The available alternatives are to reduce the use of the coal plants, to use only low sulphur coal or to introduce technologies to control the emissions of acid gas. All alternatives lead to a decreased cost effectiveness of the coal plants.

Ontario imports its coal from western Canada and the north-eastern United States. Thus the ultimate control over the prices and availability of this resource is outside the province. While the currently known coal reserves are adequate to meet the expected future needs of Ontario, the dependency on external market price movements does introduce a level of uncertainty to the electricity supply planning process.

The successful development of nuclear power enabled further expansion of the Ontario electrical system. In the CANDU nuclear generating stations, Ontario has utilized both a technology and a fuel resource which are indigenous to the Province, even though some uranium from Saskatchewan is also used. The large known reserves of uranium in Ontario can provide cost-effective fuel for many years to come.

From the perspective of future availability of the CANDU technology there are two principal factors for consideration. First, Ontario Hydro as the major builder, owner and operator of the CANDU plants has, over the past two decades, developed a high level of specialized technological expertise. This in-house technical staff enables successful completion of the nuclear stations under construction and also ensures safe operation and maintenance of both new and existing nuclear facilities.

Second, the overall slowdown of the expansion of nuclear generation in the U.S. and other parts of the world may lead to a general decline of the nuclear industry. If future sales of CANDU nuclear reactors do not materialize, the resulting downsizing of the Canadian nuclear industry could not only escalate prices of the specialized equipment needed for nuclear power plants but may also limit the availability of this equipment.

3.2.4 Other Energy Sources

Other energy sources such as wood, municipal solid waste, solar energy or wind are already meeting the demand for energy in small niches of the Ontario market. Many of these sources, if developed, could be converted to electricity for transmission to the point of use. While growth in these energy resources and their respective technologies is foreseen, their role in Ontario's energy supplies in this century will be relatively minor. According to the Ministry of Energy, these sources are expected to provide only about four percent of Ontario's energy supplies by the year 2000.

3.3 Management of Energy Resources

Ontario's economic growth and prosperity have, to a large extent, been achieved due to the availability of abundant and inexpensive energy supplies. If this growth is to continue, our access to reliable and economic energy sources must be maintained. As definite limits exist in the supply of some energy sources, the wise use of all resources is of great importance. Our society has already experienced a number of occasions when specific resources have become scarce. To prevent the elimination of certain resource options, our efforts need to concentrate on the conservation of scarce resources and the substitution of other more plentiful ones wherever feasible.

3.3.1 Protection of Scarce Resources

It has been estimated that at 1984 production rates, the world's currently known reserves of crude oil would last about 34 years. Of course, these reserves are being continuously augmented by new discoveries. The rate at which newly found reserves are brought into production is closely tied to the expectations of future oil prices, the costs of production from the new facilities and the size of the new discoveries. The size of new finds has been steadily decreasing while the costs of production are growing.

In all, the world's supply of crude oil is limited and once exhausted, it cannot be replaced. As with all limited resources, prudent management of available oil reserves is essential if we are to maximize the ultimate benefits of this resource. Due to its unique characteristics, the most valuable uses of oil in the future may be as a portable transportation fuel, a source of lubricants and a chemical feedstock. Thus, by the end of the century, electricity and natural gas are likely to replace oil in heating applications.

Increasing availability, clean burning properties and convenience have contributed to the increasing use of natural gas as a heating fuel in Ontario, mainly as a replacement for oil. While the natural gas resources in North America are considered adequate to meet the anticipated demand for this fuel, these reserves are, as in the case of crude oil, limited. Canada's currently connected supply base is estimated to be sufficient to satisfy projected demand for over 30 years.

The high cost of transportation further reduces the availability of natural gas from smaller sources where it is unacceptably expensive to construct a transportation network to deliver this gas to customers. The uncertainty of future prices of natural gas will have a particularly strong impact on Ontario, which imports 98% of its natural gas supplies. Potential price and availability fluctuations are likely to become major issues facing Ontario's gas consumers and policy makers.

Ontario's existing and committed electricity generating facilities will be able to supply the expected demand into the 1990s. The major issues facing electricity planners in Ontario will centre around assuring a balance between demand and supply through the 1990s and beyond, while maintaining the reliability required by the customers and achieving the flexibility to respond to changing customers' needs.

Of the three primary energy sources used to produce electricity in Ontario, uranium and water are both plentiful and indigeneous to the province, while coal, even though also relatively plentiful, must be imported. The relatively high, compared to oil and gas, degree of control over the supply and prices of electricity will be one of the major contributors to the anticipated growth in the use of electricity in Ontario. An effective way to preserve the relatively scarce oil and gas resources for those uses where there are few economic alternatives, is to use efficient electricity based technologies. As the electric heat pump is already becoming an accepted alternative to the oil-fired furnace, so are microwave dryers capable of replacing gas-fired ones. This increasing electrical intensity through substitution can have a substantial impact on the future electricity use patterns in Ontario.

3.3.2 Conservation Means Wise Use of All Resources

Conservation of resources does not necessarily mean "doing without". Our society has achieved a level of development where many luxuries of the past have now become everyday necessities. It can, therefore, be expected that energy conservation activities in the future will be directed at reducing our consumption of energy resources while, at the least, maintaining the quality of life of the people of Ontario.

The production of all the goods and services required to meet the needs of our society utilizes enormous quantities of labour, capital, raw materials and energy. Only wise use of all these resources will result in the greatest benefit to the society. Thus in evaluating the effectiveness of energy conservation strategies we must consider their impact on the remaining societal resources.

Energy conservation can be approached in a number of different ways. Frequently, the term conservation is used to mean simply a reduction in the amount of energy used for a specific application, often at the expense of using more capital, labour or raw materials. For example, the lower heat energy needs of super-insulated electric houses are partially offset by the greater levels of insulation, better quality windows, draft proofing etc, which all require additional resources.

The substitution of efficient use of one source of energy for inefficient use of another is also a way of achieving conservation. For example, electrical induction heating can replace oil or gas fired furnaces in many metal forging applications. Induction heats the metal directly and much more quickly and efficiently than the fossil fuels which must first heat the surrounding air which in turn heats the metal.

In some instances resource conservation can be achieved by actually increasing energy use to reduce the use of another resource. This type of resource conservation is being adopted in the pulp and paper industry by the introduction of thermo-mechanical pulping (TMP). This new method of production, results in a better quality product, reduces environmental impact, and also enables the use of inferior quality wood, previously discarded as waste. However, TMP does require a significant capital expenditure by the industry and increases the plant's demand for electricity.

The replacement of a technology that consumes a scarce, non-renewable energy source by another that uses a more plentiful fuel can also represent conservation from the societal perspective. The recent government-sponsored off-oil programs stimulated this type of conservation in the residential space heating applications.

When assessing the costs and benefits of specific energy options, many variables have to be considered in addition to the basic characteristics of the primary energy sources. The availability, cost and efficient use of capital, labour and all necessary materials must be evaluated and weighed in light of other non-economic factors such as the impact on the environment and the associated risk and uncertainty. The end point of a successful conservation strategy would then be the achievement of the greatest level of overall efficiency.

4.0 ELECTRICITY REQUIREMENTS

Within the general picture of Ontario's energy supply and demand discussed in Chapter 3, Ontario Hydro must prepare detailed forecasts of electricity demand.

These forecasts are critical to the planning activity of Ontario Hydro. The annually produced Load Forecast provides a link that joins the specific financial, engineering and demand management plans, forecasts and projections needed to manage Ontario Hydro's business. Since the corporate planning process is very complex, the following few examples are selected to illustrate some of the uses of the Load Forecast.

- Corporate strategies, power system plans, projections of financial resources, and demand management programs, all use the Load Forecast as an important input.

- The annual process of determining rates is based on detailed financial forecasts which rely on the Load Forecast for the projection of the customer demand for electricity.

- The detailed plan for production of electricity through the year is based in part on the Load Forecast. Generation dispatching, fuel purchase schedules and generation and transmission maintenance outages are some of the activities laid out using this plan.

4.1 Forecasting Methodology

To meet the diverse needs of the users of the Load Forecast, two forecasts with different time horizons are prepared each year.

The Short-Term Load Forecast quantifies the expected energy demand and customer loads for the current year and the following five years. It is used throughout the organization to plan revenue requirements, rates, budgets, fuel purchases and electricity production.

To plan the size of the power system needed to meet future demands, a long-range 20-year forecast, known as the Long-Term Load Forecast, is produced. This forecast builds on the Short-Term Forecast and is more comprehensive and far-reaching.

4.1.1 Short-Term Forecast

Electricity demand in the short run is directly related to the specific plans of Ontario Hydro customers. The Short-Term Load Forecast is, therefore, closely tied to customer load estimates prepared at the regional level. Using their first-hand knowledge of the local economy, the regional staff, in consultation with the municipal utilities and large industrial customers, prepare projections of demand for the current year and the subsequent five forecast years.

Regional totals are compiled and compared with corresponding results from a time series model which draws on 15 years of data. Judgment is then used to adjust for significant deviations.

Finally, the forecast sum of customers' loads is compared to the result of recently developed and tested short-term forecasting models, which incorporate effects of economic conditions, fuel prices, weather and other factors. This comparison results in a final adjustment to the forecast.

4.1.2 Long-Term Forecast

To quantify the effects of the complex network of factors that determine energy demand in the longer term, Hydro's forecasters use both econometric and end-use models. The principal models used are briefly discussed in this section with a more comprehensive description available in Supplementary Document - Load Forecast Methodology.

Economic-Demographic-Energy Model (EDEM) is a comprehensive multi-equation econometric model that produces long-term demographic, economic and energy forecasts. Energy demand is related to economic and demographic variables using statistical techniques. The model produces forecasts for all major fuels, in addition to electricity, in each sector of the economy (residential, commercial, industrial and transportation).

The END-USE model, on the other hand, is an engineering-oriented model which derives electricity demand from a "bottom-up" approach. It adds up the demand created by each end-use of electricity and other fuels in all sectors of the economy. A critical step in this process is the formulation of assumptions and forecasts of the energy uses in specific applications. In addition, projections of future trends in energy using technologies must be made by the forecasters.

Analysis of the results of the models, the integration of the short and long-term forecasts, and the application of further judgment are the final stages in developing the Long-Term Load Forecast.

4.1.3 Treatment of Uncertainty

The ultimate purpose of the Load Forecast is to provide a probabilistic range of the future demand for electricity. The degree of uncertainty about the Load Forecast must be specified as an integral part of the forecast itself.

Uncertainty in the load forecast arises from uncertainty about the many factors that influence energy consumption. Most important are the level

of population and economic activity; energy prices; and the response of energy users to changes in these factors.

To recognize this uncertainty, forecasts are presented as a range, not just as a single most likely forecast. The range forecast implies no one outcome is so certain that we can plan for it and no others. This range is derived by statistical techniques that assume the world is just as uncertain now as in the past. The message from the forecasters to the planners and engineers is that the future demand for electricity has a 60% probability of being within the range. The 60% probability band has been selected for planning purposes because it provides a reasonable trade-off between the level of uncertainty of the forecast and the width of the range.

In addition to the statistically derived uncertainty range, some of the uncertainties associated with the economic variables in forecasting are addressed by the use of alternative scenarios such as:

- BETTER ECONOMIC GROWTH combines relatively high real GNP growth with relatively low inflation.
- WORSE ECONOMIC GROWTH combines low GNP growth with low inflation.
- HIGH INFLATION combines low and unstable economic growth with high inflation.

Further discussion of the two methods used to treat uncertainty in the load forecast is available in the Supplementary Document - Load Forecast Methodology.

4.2 Forecasting Process

The annually produced Load Forecast Report provides a snapshot of results of the continuously evolving forecasting process.

Hydro's forecasters monitor the many factors that influence demand for electricity and other fuels on an on-going basis. By the end of each summer, the best available information is input to the models and the results consolidated into an electricity forecast. In order to maximize the objectivity of the forecast, a number of formal and informal reviews are undertaken.

A review of the forecast by an internal advisory committee, consisting of senior managers of units of the organization who have an interest or a stake in the load forecast, forms an important part of the review process. Of similar significance are the advice and recommendations of an external advisory committee, a panel of experts from governments, energy companies (including oil and gas), consulting firms and academia who review and critique Hydro's forecast in an all-day face to face session with those who prepared it.

In addition to these regular forms of review and consultation, the load forecast is, in its role as an important planning tool, often discussed and analyzed at various public forums. The annual Ontario Energy Board hearings and the recent deliberations of the Select Committee on Energy are examples of the type of public scrutiny the load forecast receives.

4.3 Load Shapes

The demand for electricity is closely related to our daily activities and to variations in seasonal weather. This changing character of electricity consumption, or electrical load is referred to as "load shapes".

The "annual load shape" reflects the changes in the electrical load over the course of the year. Figure 4.1 shows the annual load shape over the past three years. It shows the actual shape of the demand for electricity experienced on the Ontario Hydro system over that period of time. We can see that, due to our harsh climate, the annual peak demand occurs during the cold winter months. The 1986/87 winter peak occurred on December 8th, 1986 and reached about 20,600 MW.

There is also a summer peak period between mid June and the end of August. This summer peak results from offices and residences using air conditioning units and fans to cool off on hot and muggy summer days. Since the mid 70s, the summer peak has been increasing at a faster rate than the winter peak, as more people acquire air conditioning units, but it is still 15 to 20% below the winter peak. In some parts of the Ontario Hydro system such as Etobicoke, Hamilton and Toronto, the summer peak has frequently exceeded the winter one.

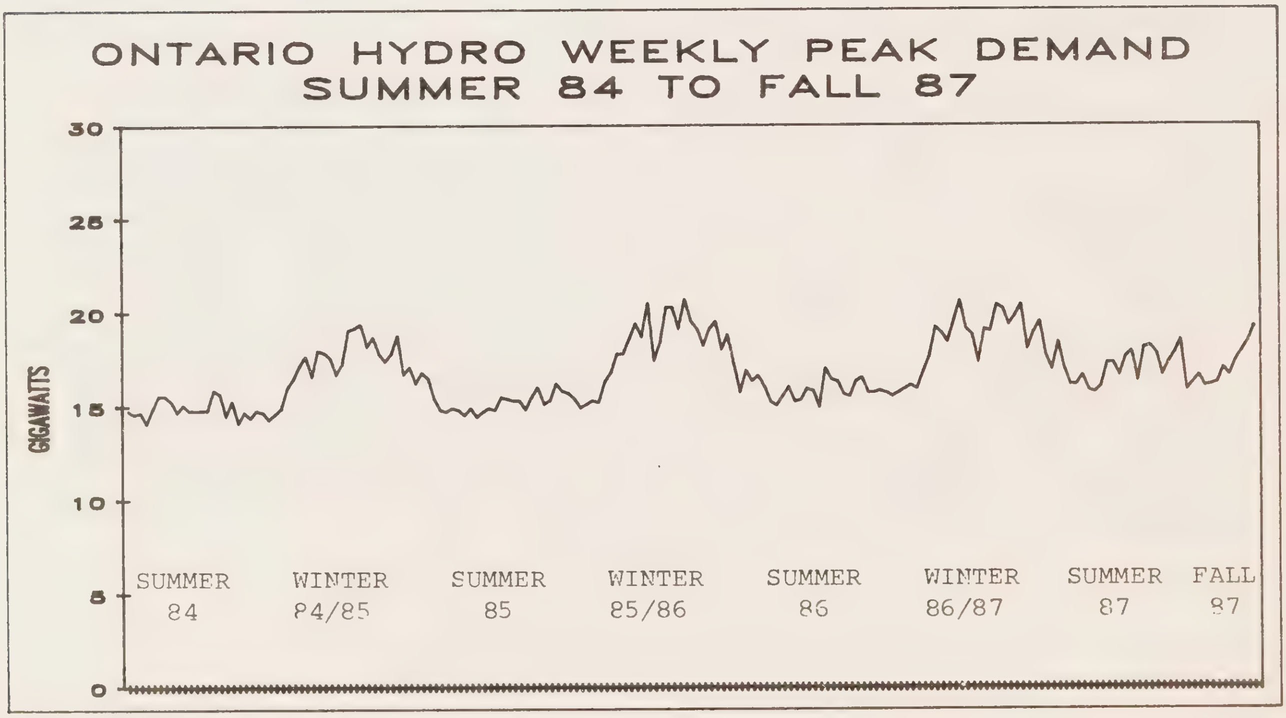


Figure 4.1

While the annual load shape curve of Figure 4.1 shows the maximum demand for electricity measured on the highest load day of each week of the year, it is also important for a supplier of electricity to understand how the use of electricity changes during each day. This is portrayed by the "daily load shape".

For example, the shape of demand during the 1985/86 winter peak day (Figure 4.2) shows that the peak demand actually occurred at around 5:30 pm when most people cook dinner and turn on lights. In summer the peak tends to occur during the late morning. However, in both cases the load is relatively flat between 8:00 am and 11:00 pm.

The load shapes define the relationship between peak demand and average demand. The average annual demand of Ontario Hydro's customers is roughly 2/3 of their winter peak demand. Since electricity cannot be conveniently stored, the power system must be designed to meet the peak demand. This may result in some generating capacity not being fully utilized in the off-peak periods. One alternative is to encourage customers to shift load from peak to off-peak times to reduce the need for more capacity.

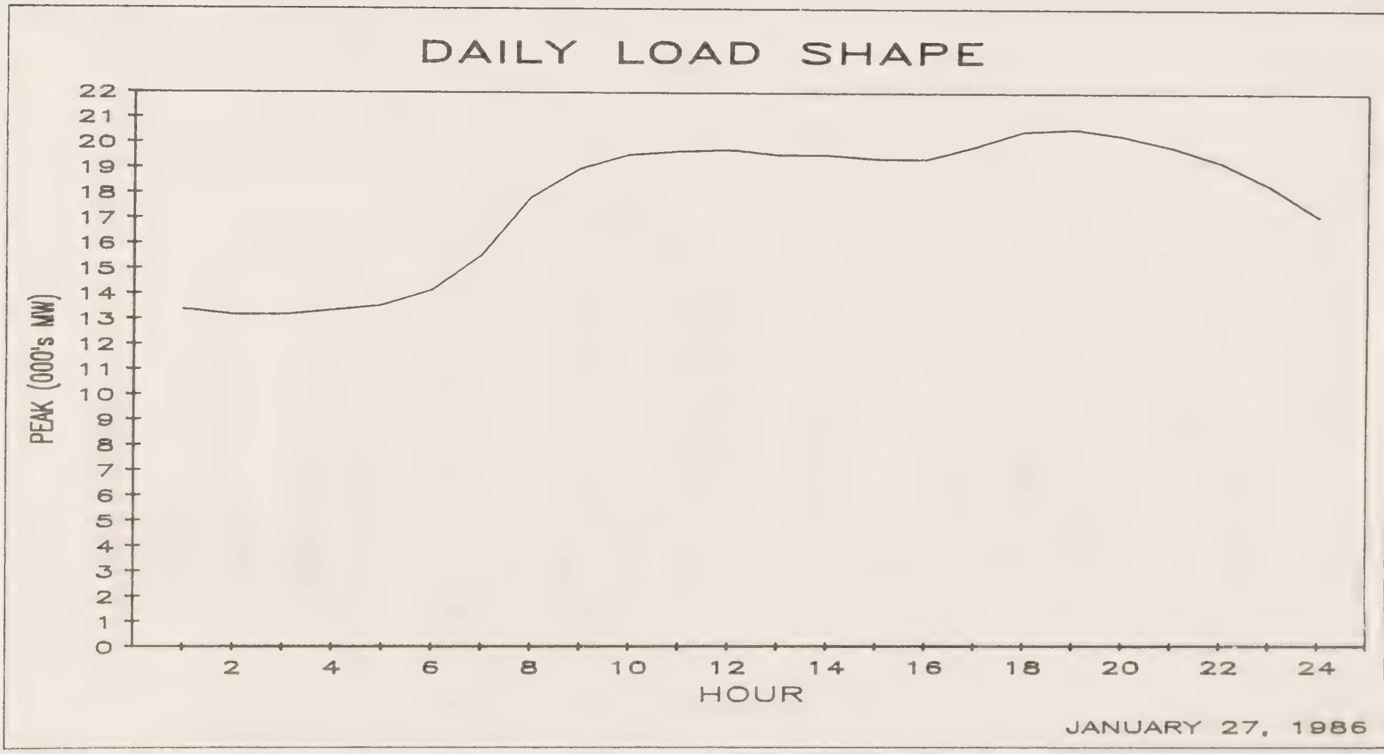


Figure 4.2

The peaking behaviour of the electrical load is a challenge facing all electrical utilities. Ontario Hydro recently informally surveyed the top 100 U.S. utilities. Eighty-eight of these utilities have much greater differences between their peak and average energy demands than Ontario Hydro. This makes their capacity planning task more difficult than ours. However, they do have more opportunities to reduce capacity needs by load shifting.

Variability of demand is not peculiar to electricity utilities. Public transit systems, telephone companies, etc, also experience peak demand periods. The major difference is, however, that an electricity company cannot give the customers a busy signal or make them wait for the next bus. The supply of electricity is expected to match demand at every instant. In spite of the fairly high variability of demand, electricity companies achieve capacity utilization rates that compare favourably with most other industries that have fluctuating demand.

4.4 Peak and Energy Demand Growth

Understanding how the demand for electricity changed in the past helps in the development of forecasts of its trends in the future. Figure 4.3 shows the actual year-over-year rate of growth of electrical energy consumption experienced in Ontario since 1972. For many years prior to 1977, electricity growth averaged about 7% per annum. However, from 1977 to 1981, the year-over-year growth rate was around 2.5%. Demand actually fell during the recession of 1982, but the pattern of low growth from 1977 to 1982 was broken in 1983, 1984, 1985 and 1986. These four years had 5.2%, 5.9%, 3.3% and 3.9% year-over-year growth rates respectively. Load growth in 1987 is expected to exceed that of 1986.

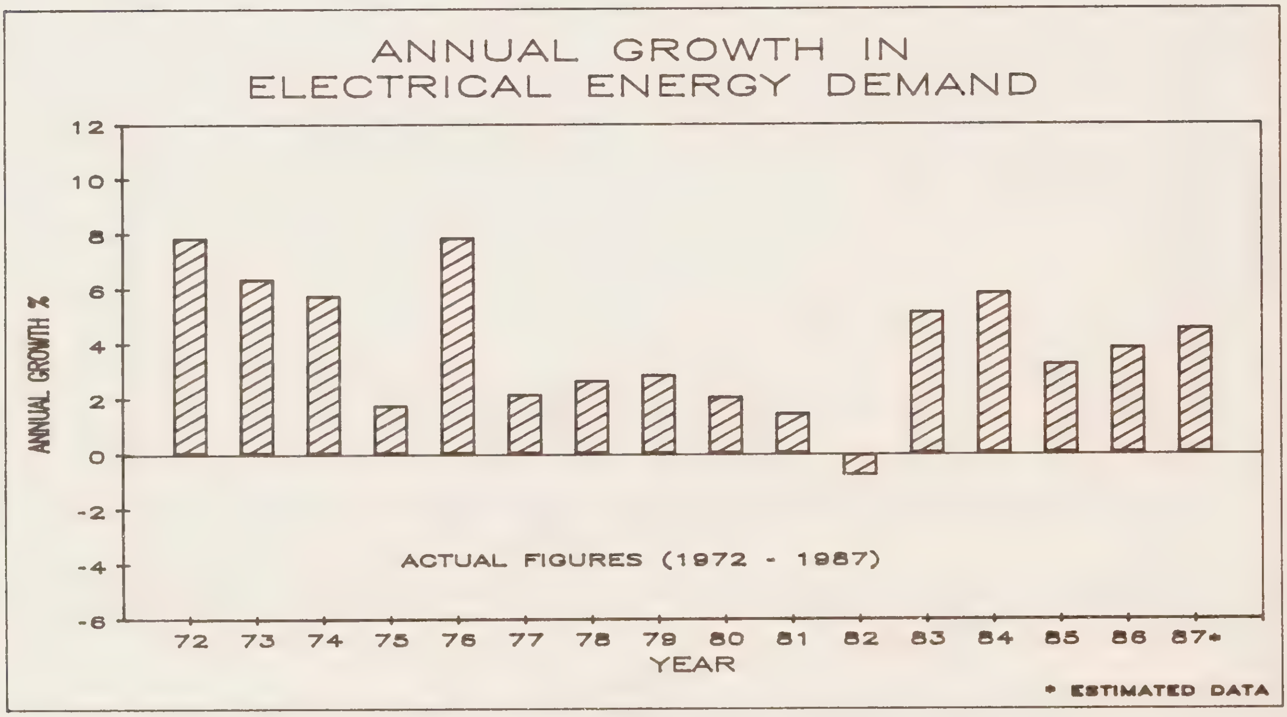


Figure 4.3

An examination of the long-term trend (actual in the past and expected in the future) of the average percentage changes in electrical energy demand (Figure 4.4) in each decade since the 1930s shows steady growth rates until 1970, followed by a decline in the 1970s and 1980s. However, due to changes in the size of the base, percentages give a misleading picture. The units used to measure energy demand are kilowatthours or terawatthours, not percentages. When the average additional new energy we had to produce each succeeding year is plotted (see Figure 4.5) the trend is quite different. While the accelerating growth in new demand from the 1930s to the 1960s is over, there has not been a reduction in absolute growth of electrical energy demand. Since the 1960s, absolute growth has been approximately constant and we expect the current level of growth will continue into the next century.

Moving now from energy to peak demand, Figure 4.6 shows that the actual winter peaks are much more volatile from one year to the next than is energy demand. The main reason for the large fluctuations in peak growth is that peak demand is more sensitive to weather conditions. Extreme weather can cause a deviation from forecast, on the basis of temperature alone, of around 3% either way. Other significant weather factors such as wind speed, illumination, humidity in the summer time and the length of the cold spell in the winter time also affect the demand for electricity. Over the long term, however, the effect of weather averages out.

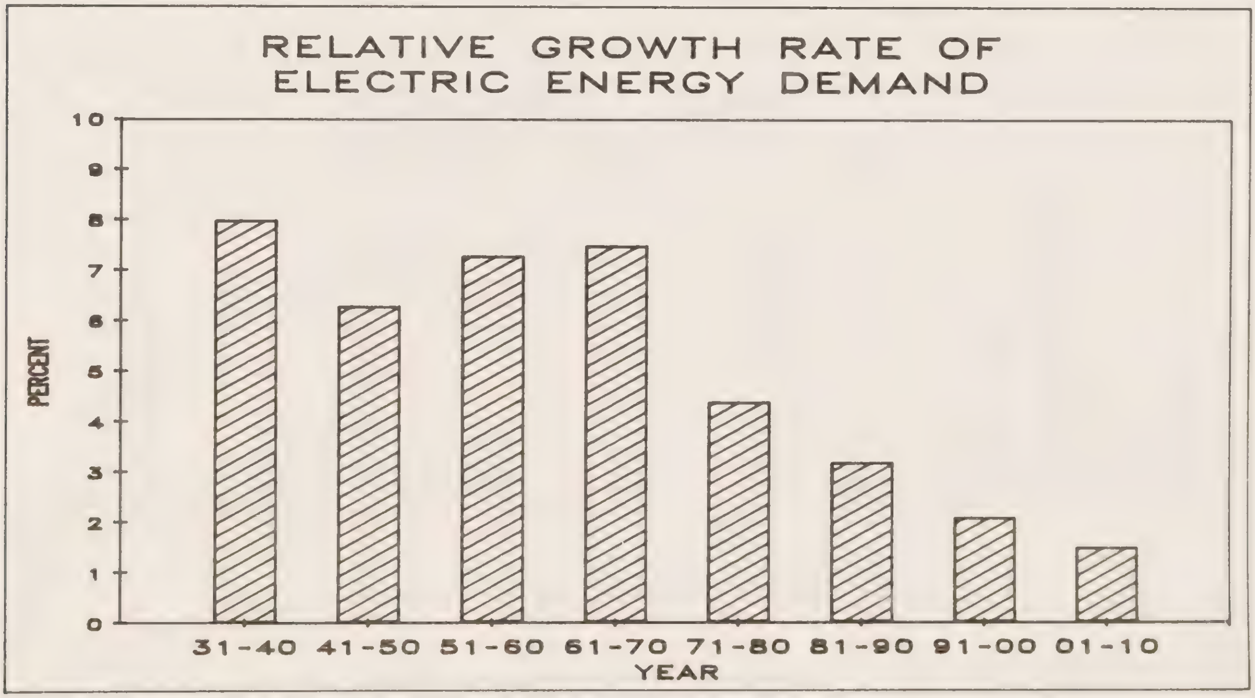


Figure 4.4

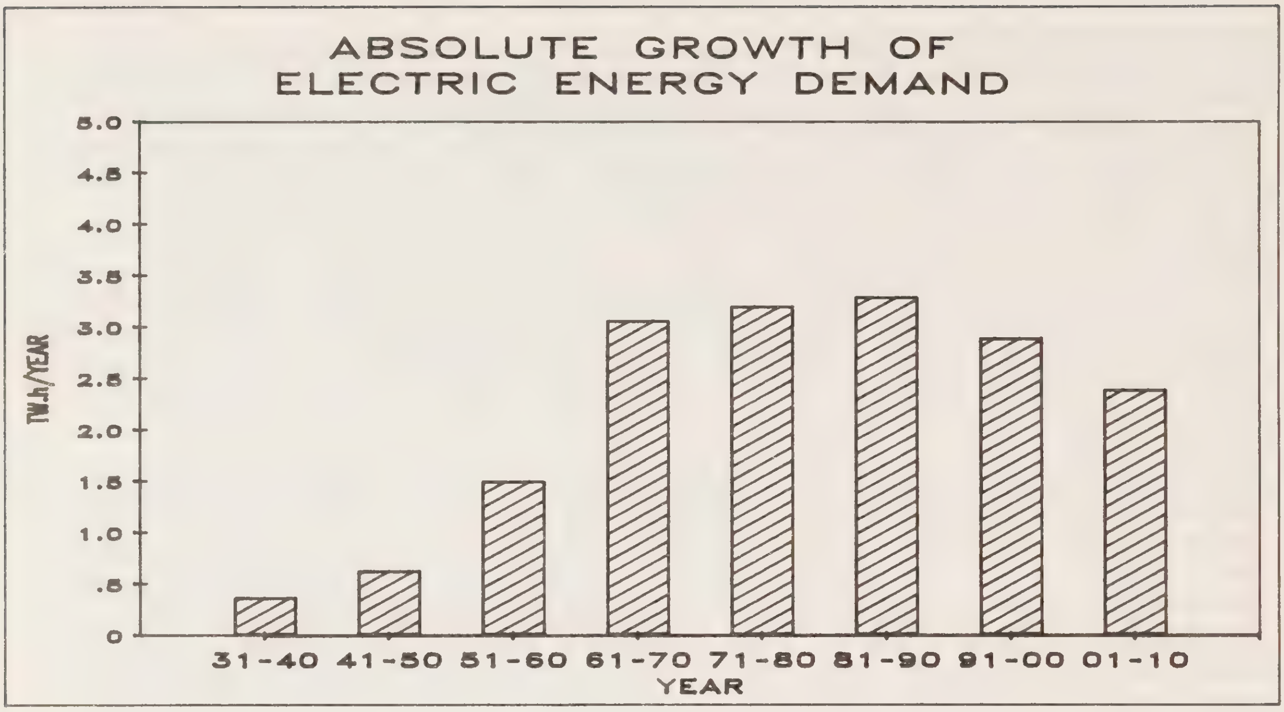


Figure 4.5

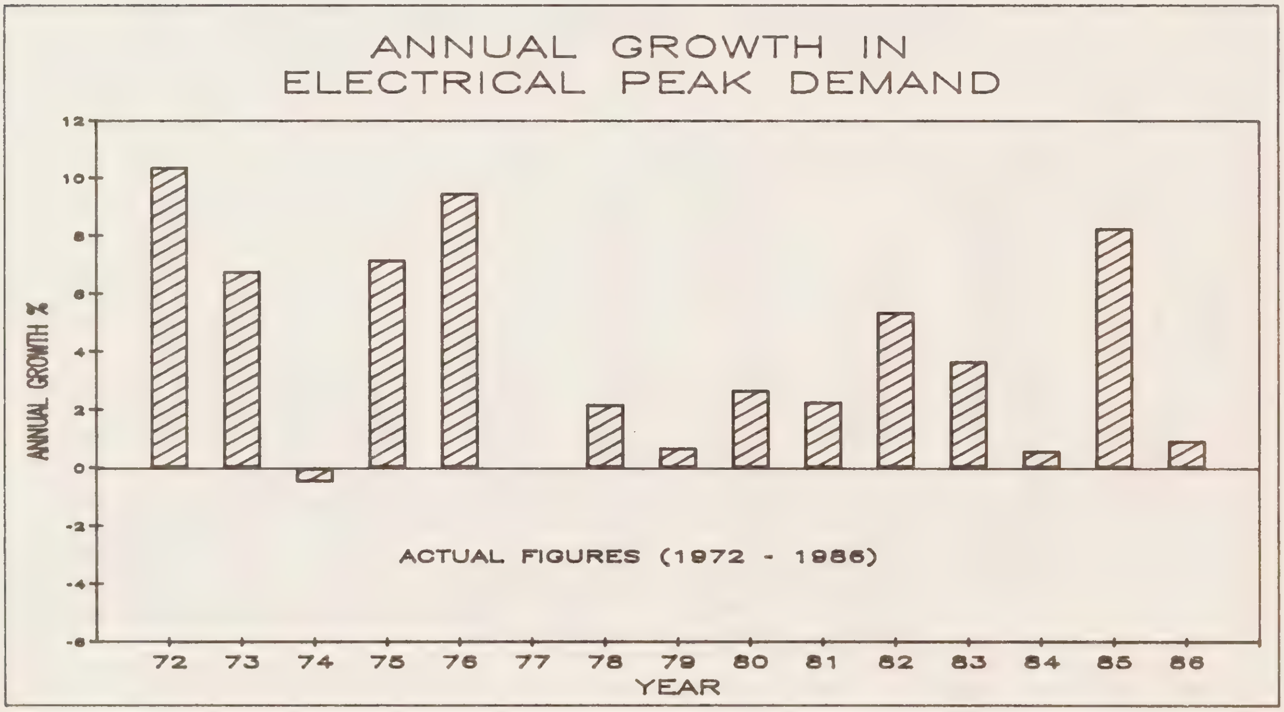


Figure 4.6

Furthermore, it is quite difficult to identify exactly how much of the deviation from peak forecast is due to weather and how much is due to increased electrical demand caused by a surge or lull in economic activity.

Given these difficulties in forecasting peak, we concentrate on forecasting energy demand and derive the expected peak using "normal weather" assumptions. The variation in peak due to weather is one of the uncertainties that is taken into account in designing the power system.

4.5 Long-Term Load Forecast

The long term load forecast described in this chapter and used for the studies described in this report was approved by Ontario Hydro's Board of Directors in December 1986. A new forecast will be submitted for approval in December 1987. The long term trend of the recommended forecast is not significantly different from the previous year and would not change the conclusion of this report with respect to the Demand/Supply Planning Strategy.

Ontario Hydro's long-term forecast projects a growth rate of demand for electrical energy from 1986 to 2005 of about 2.4 percent per year. But this is only the most-likely forecast. Recognizing that the world is highly uncertain and assuming that the world is no more uncertain than it has been in the past 20 years, we estimate that there is a 20 percent chance that demand will grow by 4.3 percent a year or more, and a 20 percent chance that growth will be nearly zero or may even decline. That leaves a 60 percent probability of being within the band shown in Figure 4.7.

Figures 4.8 and 4.9 have this forecast added to the curves of historical energy consumption and annual peak demand to illustrate that the uncertainty band is quite wide. By 2005, the difference between the upper and lower load projections is larger than the electrical energy generated in 1986 by the total Ontario Hydro system.

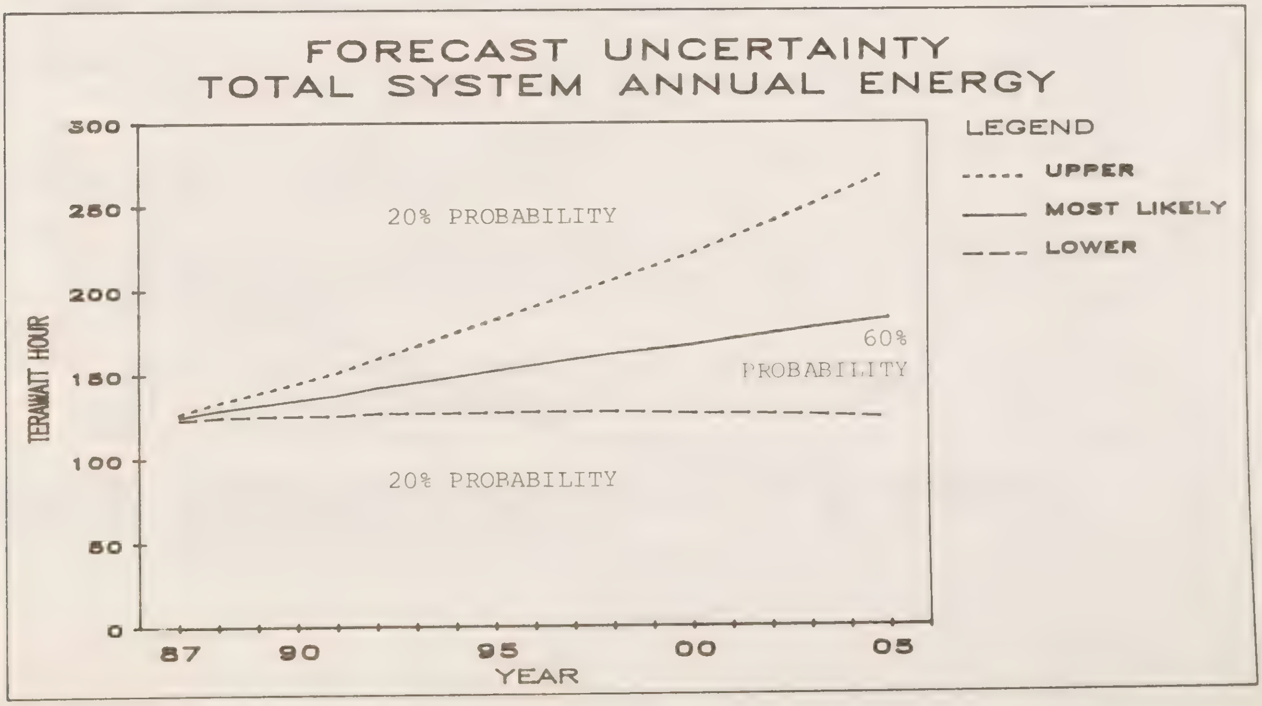


Figure 4.7

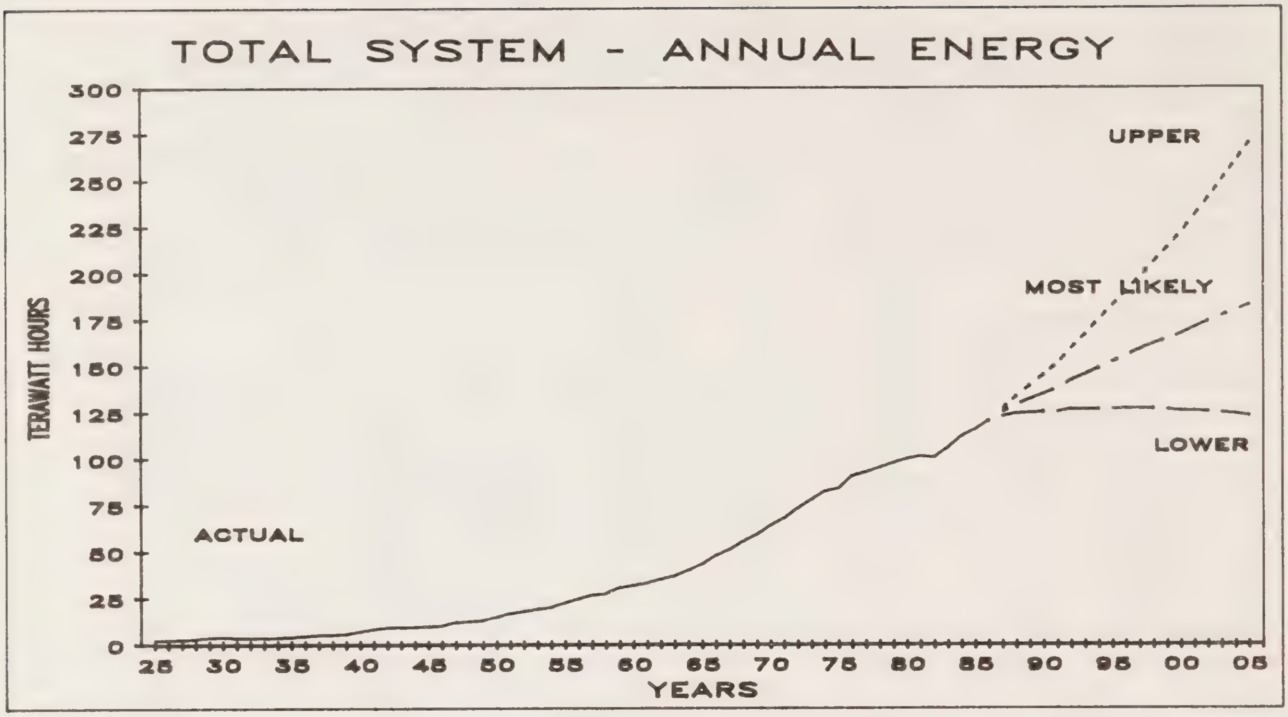


Figure 4.8

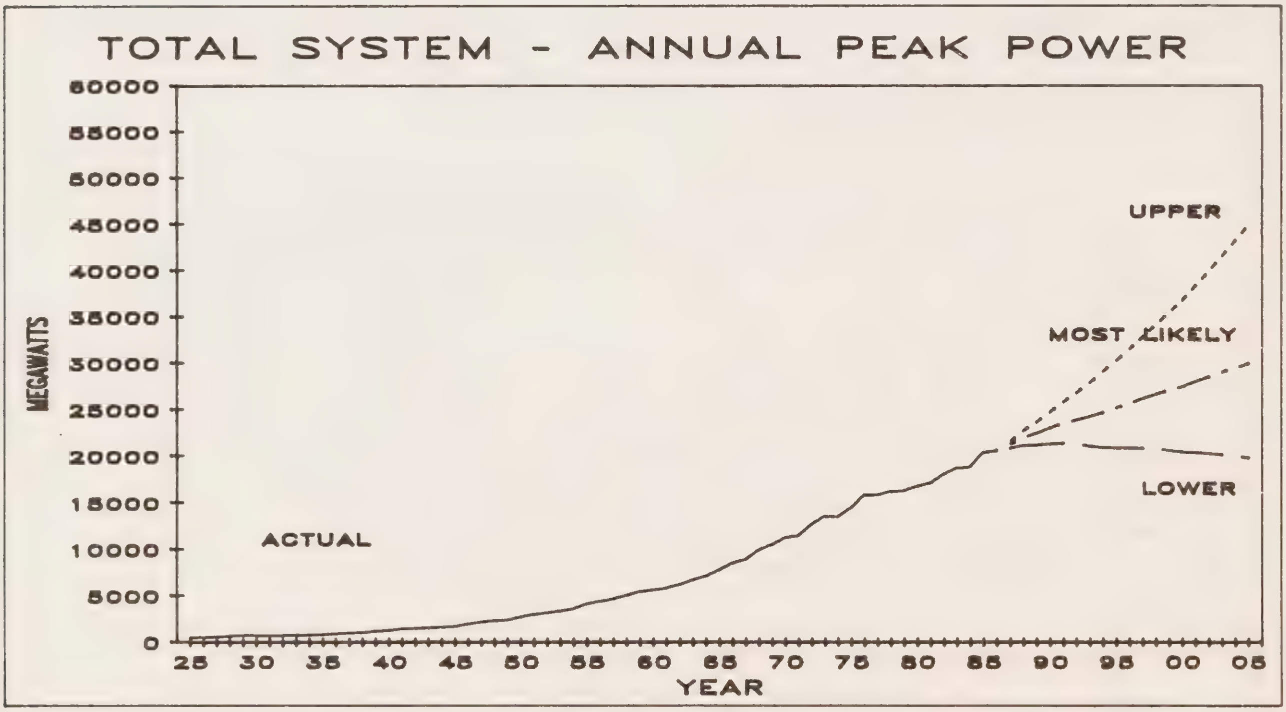


Figure 4.9

The alternative scenario method results in a range similar to that produced by the error modelling band outlined above.

The 60 percent confidence band is considered very seriously by planners who must recognize the full range of alternative possibilities. They must consider actions they can take now that would allow them the flexibility to meet unexpectedly higher demand, without being too costly if the demand turned out to be on the lower side. For example, a mothballed plant could be placed in service relatively quickly to meet unexpectedly high loads, yet it is not too costly if it turns out to be unneeded.

Flexibility costs money. But not being able to satisfy higher demands could be even more costly. Some businesses may have to curtail their expansion, and we may be in the unfortunate position of not being able in this province to sustain an expanding economic activity. There is no one plan which could meet all conditions and be at the same time low cost.

4.5.1 Major Assumptions in the Forecast

The reference load forecast was produced using a combination of the principal models discussed in Section 4.1.2 and the judgment and experience of Ontario Hydro forecasters. The following major assumptions were used in preparing the forecast.

- Economic growth will follow the path outlined in the most-likely forecast of the Economics and Forecasts Division's Economic Outlook, Annual Review 1986. This outlook predicts real economic growth in Ontario averaging about 2.8 percent per year over the period 1986 to 2005.

- Ontario population in the year 2005 will be about 10.8 million.

- Ontario labour force in the year 2005 will be 5.8 million, at an average participation rate of just under 70 percent.

- The price of electricity will decline in real terms, or in other words, rate increases will generally be less than inflation.

- There will be no major disruptions of energy supplies such as the OPEC oil crises of the 1970's.

- The rate of technical progress will recover from its recent negative values to a level below the average of the 1960s, but above the average of the last decade.

- The stability of social, economic, and financial institutions will be retained. No international financial crisis will seriously affect the Canadian financial system.

The recent stock market adjustment, in October 1987, is not expected to affect the long term forecast.

4.5.2 Relationship of Electricity Use to Economy

One of the most important factors influencing electricity demand is the level of economic activity. In fact, the economy of the province, measured by the gross provincial product (GPP), and the demand for electricity have been closely linked since the beginning of electricity generation in Ontario. But the exact relationship has changed over time in response to a number of factors.

To illustrate this, we have calculated how much electricity was used per dollar (constant 1971$) of the gross provincial product in every year from 1945 to 1986 (Figure 4.10). The graph shows that Ontario used more and more electricity in the 1940s, 1950s and 1960s, when electricity prices were falling in real terms and the province was industrializing rapidly. From the mid 1960s through the 1970s growth slowed. Over the the period 1983 to 1986 there has been no increase in the amount of electricity used to produce each dollar of GPP.

The question we ask ourselves now is whether the earlier relationship will hold its course or whether it will change as a result of an increasing movement toward energy conservation. In our current forecast we estimate a change in the long term historical trend. We project that increasing efficiency in electricity use will balance the new uses of electricity enough to make the amount of electricity we consume per dollar of output continue the recent trend. This would be a reverse of the trend of the previous 60 years.

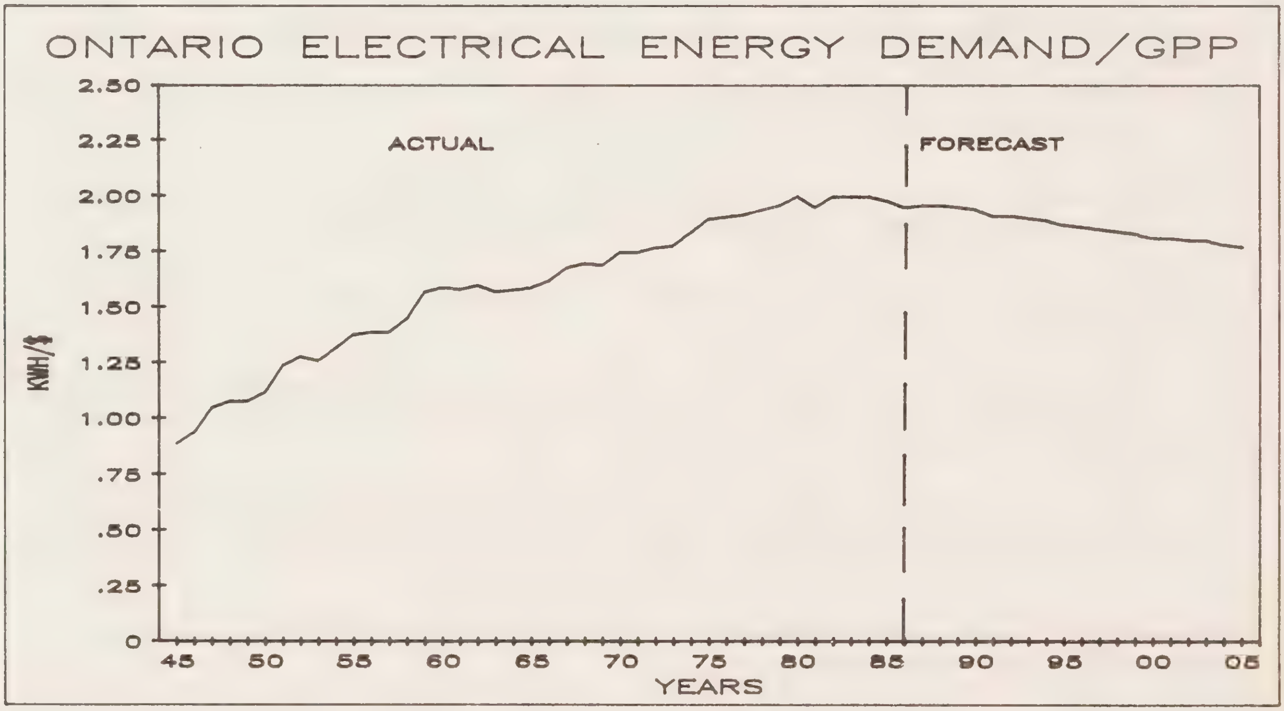


Figure 4.10

4.5.3 Quantification of Demand Management Potential

To evaluate new ways of increasing efficiency, demand management planners need to know how big an increase in efficiency can be achieved by specific incentive-driven conservation programs. To do this, they first need to know how much efficiency improvement is already included in the Load Forecast. That means the amount of "natural conservation", which consumers undertake on their own initiative must be calculated.

We do this by taking the difference between two separate end-use forecasts. One reflects our best set of conservation assumptions, the most likely forecast described in previous sections. The other shows what would happen if consumers did not increase at all the efficiency with which they use electricity.

A clear understanding of the meaning of natural conservation is necessary to avoid counting any future conservation measure twice; once in the Load Forecast and then again in the list of possible future demand management activities. Once we know what efficiency improvements are likely to occur without incentives, we can be more confident about the net savings that demand management programs may provide.

4.6 Developments in Load Forecasting

In the steady growth years of the sixties and early seventies, forecasting the demand for electricity was done using rather simple techniques and still the accuracy of the forecasts was acceptable. However, the increased volatility of energy prices and economic conditions in the 1970s and early 1980s has necessitated the development of more sophisticated forecasting models. At present Ontario Hydro uses large-scale econometric and end-use models to meet the changing demands of the load forecast users.

The evolution of the planning systems at Ontario Hydro to enable integrated analysis of demand and supply planning options creates new demands on the load forecasting function. It is no longer adequate to only prepare an annual "official load forecast". Instead, the scope of the forecasting process is being broadened to include highly customized load impact analyses to meet the specific needs of planners, engineers or marketers. The assessment of the impact on load of the introduction of new industrial production technologies or an increase in the construction of R-2000 houses are examples of the analyses required. As the majority of these needs relate to particular end-uses of electricity, the end-use forecasting capability is being strengthened. Close ties have been developed with forecasters in Canada and the United States. Of particular importance are the recent acquisitions of forecasting models from the Electric Power Research Institute (EPRI). These models, which combine both end-use and econometric methods, are being incorporated into Ontario Hydro's portfolio of models.

5.0 THE CAPABILITY OF THE EXISTING & COMMITTED SYSTEM

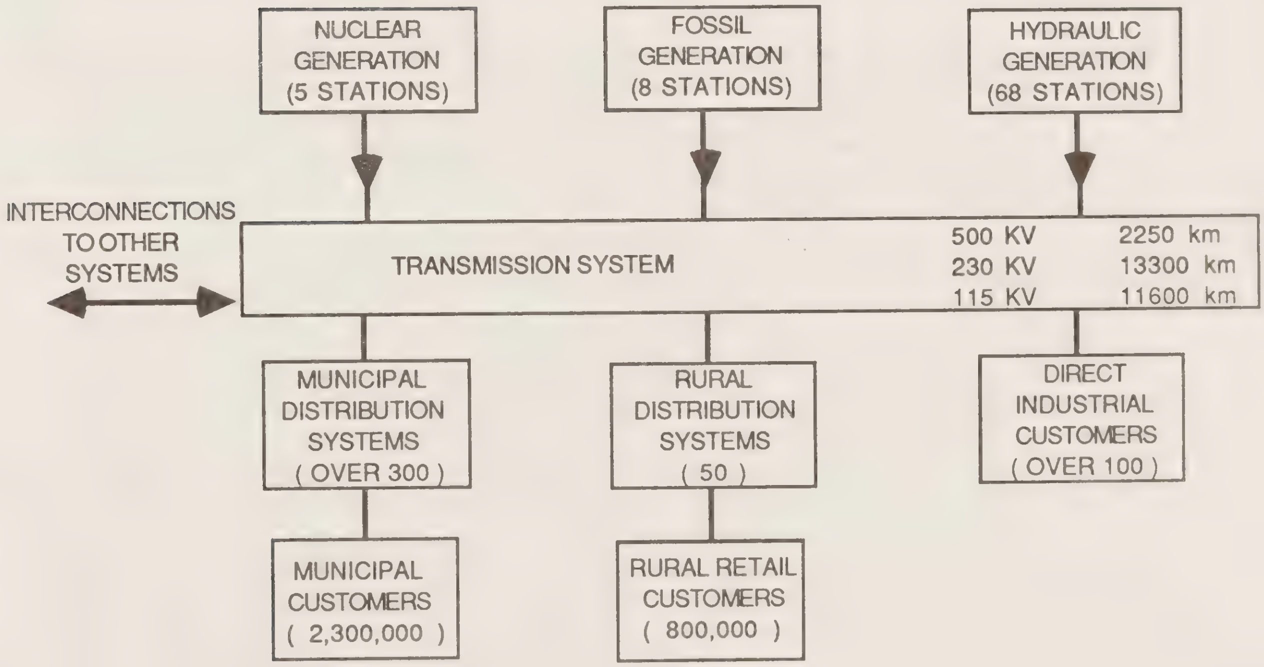
The starting point in power system planning is the existing system, including any additions committed but not yet in service. This chapter describes the existing and committed generation and the amount of electricity it can supply through the transmission system to the people of Ontario.

The figures in this chapter were derived from the 1986 Bulk Electricity System Resources Plan (Report 653SP). Since then, minor adjustments have been made to accommodate the planning assumptions as depicted in the 1987 Bulk Electricity System Demand/Supply Report (Report 661SP). However, the discussion is still valid as the existing and committed generation facilities remain unchanged.

FIGURE 5.1

DIAGRAM OF TOTAL SYSTEM

EXISTING & COMMITED



5.1 Existing and Committed Facilities

The total bulk electricity system consists of generation, transmission and distribution facilities which supply electricity to the people of the province (Figure 5.1). Ontario Hydro is responsible for most of the generation and transmission but for only part of the distribution facilities. Over 300 independent municipal utilities buy their power wholesale from Ontario Hydro and distribute it within their service areas. Ontario Hydro sells power directly to over 100 large industrial customers and through its distribution system to 800,000 retail customers located primarily in rural areas that are not served by a municipal utility.

Ontario Hydro also provides power to many small communities in northern Ontario which are so remote that they are not connected to the main power system. In most cases these communities are supplied from local diesel-electric generation and a few are supplied by local hydraulic generation. The supply to these remote communities is not the primary focus of the Demand/Supply Options Study.

The Ontario Hydro bulk electricity generating system consists of a mix of hydraulic, fossil and nuclear units. By 1993, when Darlington is scheduled to be completed, there will be a large number of relatively small hydraulic units in place - 272 units with capacity ranging from less than 1 MW to 135 MW, and 28 fossil units with capacity ranging from about 300 MW to 500 MW. The largest units on the system will be nuclear with 20 units having capacities ranging from 500 MW to 850 MW. There will also be 22 small combustion turbine units with capacity ranging from about 2 MW to 20 MW.

These units are located in 80 generating stations spread across the province which are interconnected by over 27,000 km of transmission circuits (Figure 5.2). In turn, the transmission system feeds the distribution systems that serve more than three million customers. The Ontario Hydro bulk electricity system is also interconnected with similar systems in Michigan, New York, Quebec and Manitoba.

While Ontario Hydro provides most of the generation in the Province, there are also small generating facilities which are owned by industrial customers, municipal utilities, private utilities, and independent power producers. This independent generation amounts to about 1200 MW or 4% of Ontario's total generation. About half of this generation is hydraulic and most of the remainder is industrial cogeneration using wood wastes or natural gas as fuel. Since this independent generation is now used almost entirely to reduce its owner's electricity demand from Ontario Hydro and not to supply other Ontario needs, it is not considered further in this chapter.

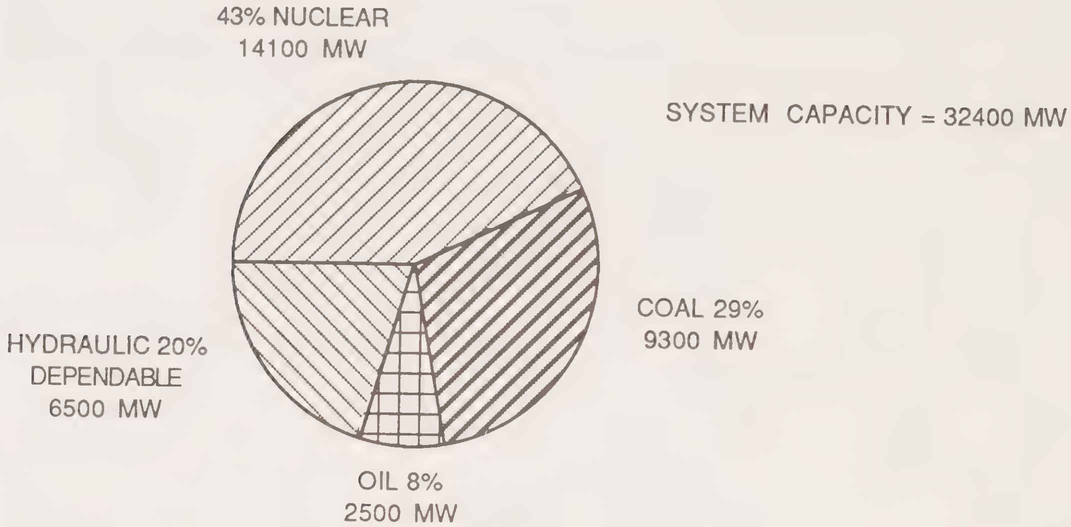
The existing and committed Ontario Hydro generation facilities will total about 32,400 MW by 1993 when Darlington is completed (Figure 5.3). This total includes 2237 MW of oil-fired capacity at Lennox Generating Station but excludes 1458 MW capacity of older, inefficient gas and coal-fired units with high operating costs at Keith and Hearn Generating Stations, which are assumed to retire in 1989. (The Lennox GS was mothballed in the early 1980s because of high operating costs and surplus capacity. Two of the four units were readied for service in 1987, to maintain system reliability and to meet short term peak power demand, if needed.) By 1993, the capacity mix will be 20% hydraulic, 43% nuclear and 37% fossil generation. The 37% fossil generation in turn consists of 29% coal and 8% oil and combustion turbines. Thus the system has the ability to produce electricity from a diversified mix of fuels.


ONTARIO HYDRO
MAJOR 500 kV AND 230 kV LINE ROUTES AND STATIONS
(AS OF MID 1987)
WEST SYSTEM
TO WEST SYSTEM (SEE BOX)
KIPLING
HARMON
LITTLE LONG
OTTER RAPIDS
ABITIBI CANYON
PINARD
KAPUSKASING
PORCUPINE
DYMOND
LAKE TIMISKAMING
LOWER NOTCH
AUBREY FALLS
HANMER
MARTINDALE
WELLS
OTTO HOLDEN
DES JOACHIMS
CHENAUX
CHATS FALLS
MOUNTAIN CHUTE
PARRY SOUND
MUSKOKA
MINDEN
HINCHINBROOKE
SMITH FALLS
R.H. SAUNDERS
BROCKVILLE
LENNOX
DARLINGTON (N)
PICKERING (N)
HEARN (F)
LAKEVIEW (F)
TRAFALGAR
ORANGEVILLE
CLAIREVILLE
RICHVIEW
MILTON
SEAFORTH
DETWEILER
MIDDLEPORT
SIR ADAM BECK
NANTICOKE
LAMBTON
BUCHANAN
BRUCE
TO MICHIGAN
TO NEW YORK
TO QUEBEC
MANITOBA
MINNESOTA
QUEBEC
MICHIGAN
NEW YORK
CANADA
UNITED STATES
LAKE SUPERIOR
LAKE HURON
GEORGIAN BAY
LAKE NIPISSING
LAKE SIMCOE
LAKE ONTARIO
LAKE ERIE
James Bay
Moose River
Abitibi River
Mattagami River
Ottawa River
St. Lawrence River
Timmins
Sudbury
North Bay
Sault Ste. Marie
Barrie
Toronto
Hamilton
Kitchener
London
Sarnia
Windsor
Niagara Falls
Cornwall
Kingston
Peterborough
Ottawa
RED LAKE
TROUT LAKE
EAR FALLS
MANITOU FALLS
CARIBOU FALLS
WHITEDOG FALLS
KENORA
DRYDEN
LAC SEUL
SIOUX LOOKOUT
LAKE OF THE WOODS
LAKE ST. JOSEPH
ALBANY RIVER
LAKE NIPIGON
BERALOTON
PINE PORTAGE
CAMERON FALLS
ALEXANDER
AGUASABON
MARATHON
MANITOUWADGE
SILVER FALLS
LAKEHEAD
KAKABEKA FALLS
THUNDER BAY
THUNDER BAY (F)
ATIKOKAN (F)
MACKENZIE
FORT FRANCES
RAINY RIVER
WAWA
(500 KV CONSTRUCTION)
LEGEND
EXISTING MAJOR HYDRAULIC GS
THERMAL GS (EXISTING OR UNDER CONSTRUCTION)
EXISTING 500 kV LINE ROUTE
500kV AUTHORIZED
AUTHORIZED 500kV AND/OR 230kV TRANSFORMER STATION
INTERCONNECTIONS

Figure 5.2

FIGURE 5.3

COMPOSITION OF EXISTING & COMMITTED CAPACITIES



5.2 <u>System Operations and Minimization of System Costs</u>

To meet Ontario's electricity needs reliably, a reserve of about 24% is planned to allow for contingencies such as equipment breakdowns or unexpectedly high demand (Section 2.3.1). Thus Ontario Hydro's 32,400 MW of generation in 1993 can only be expected to meet a peak demand of about 26,000 MW reliably. Demands higher than 26,000 MW can be met, but at reduced reliability.

People's electricity needs fluctuate from hour-to-hour and day-to-day. On a system basis, peak demands are generally encountered on the coldest winter days. On milder days, on weekends, during the nighttime, and in other seasons of the year, demands are less than the peak value. Therefore, some of the generating capacity required to meet the peak demand need not be operated much of the remaining hours in the year. The mix of capacity and the design of stations has been chosen to meet this fluctuating need economically.

The fuel cost of the different types of generation varies widely. Hydraulic generation is the cheapest to operate because the fuel is free except for a water rental paid to the provincial government. Nuclear fuel costs about twice as much as the water rental but is still relatively low cost. Coal costs about five times as much as nuclear fuel to produce the same amount of electricity. Until recently, the cost of oil has been more than twice the cost of coal and more than ten times the cost of nuclear fuel. Recent lower oil prices have substantially reduced the difference in cost between oil and coal. However, oil prices are expected to rise again relative to coal.

While planning strategies aim to minimize the total cost of electricity in deciding what options to develop, operating strategies must work with the existing system and can only affect fuel and other operational costs.

The operating strategy for the system is to supply people's electricity demand at the lowest cost. This is done by using generating plants with the lowest operating costs first, such as hydraulic and nuclear generation, to meet as much of the energy demand as possible. Then, the progressively more costly generating plants like coal and finally, oil-fired plants, are used to meet the remaining demand (Figure 5.4).

Hydraulic plants have the lowest operating costs, but some of them cannot be run continuously since they have been specifically designed to meet short duration peaks and do not have enough water to operate at maximum capacity all the time. Operation at maximum capacity is restricted to a few hours over the peak periods of the day. During off peak periods the units are operated at less than capacity or even shut down to allow water to be stored.

Figure 5.4
TYPICAL USES OF GENERATION RESOURCES

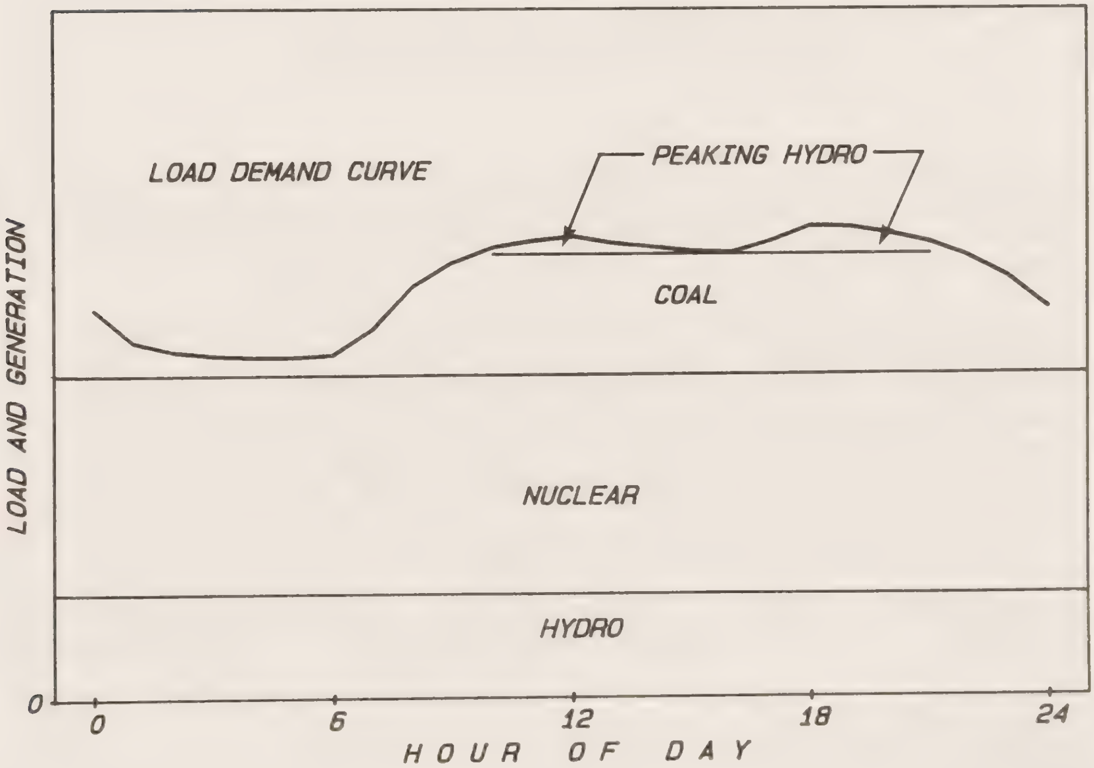
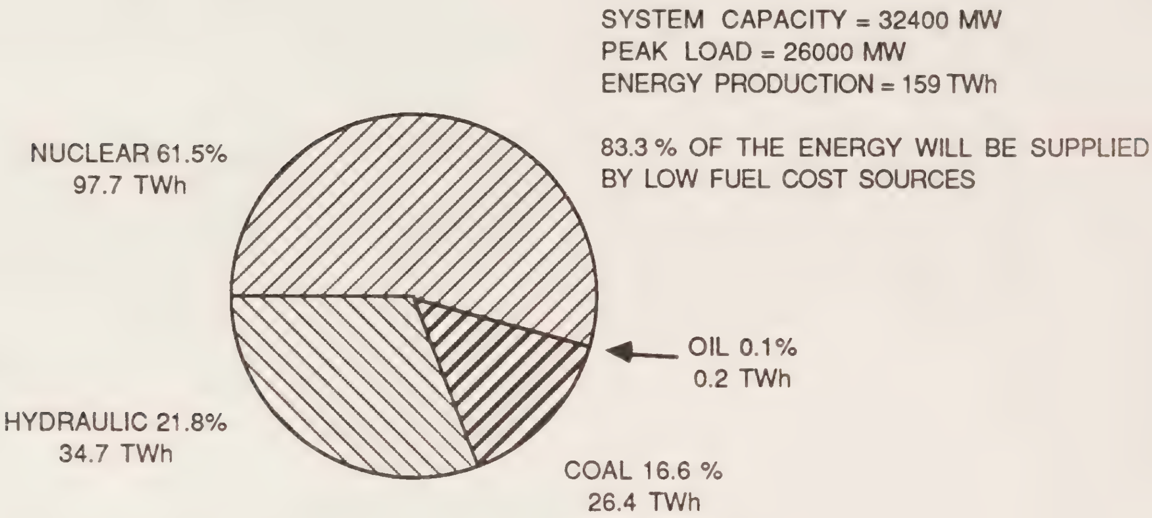


FIGURE 5.5

ENERGY PRODUCTION BY GENERATION TYPE 1993



The effect of this operating strategy can be illustrated by considering a year with a peak load of 26,000 MW. Figure 5.5 shows how the total annual energy of 159 TW.h corresponding to this peak demand would be met by each type of generation.

Therefore, energy production from nuclear, fossil and hydraulic generation is not in proportion to their shares of system capacity. Using this strategy, the fuelling costs are about one half of what they would be if energy production was balanced among the units in proportion to the capacity available. The generating capability and energy production mix of Ontario Hydro's power system by 1993 are summarized in Table 5-1.

TABLE 5-1

Generation Type	Capacity in % of System Total	Energy Production in % of System Total
Nuclear	43	61
Hydraulic	20	22
Coal	29	17
Oil	8	Less than 0.1

3198G

In years when peak demands are lower than 26,000 MW, high cost generation would be used less or mothballed. Proportionately more would be supplied by low cost generation, lowering the system average fuel costs. If peak demand in a year were to rise above 26,000 MW, interruptions to customers would be more frequent because of inadequate reserves to deal with contingencies. In addition, system average fuel costs would rise because more energy would be supplied by higher cost fossil resources.

The reliability target and reserve margin for the system were selected by balancing the costs to the customer of interruptions with the costs of supplying additional reserve generation. Operation over a prolonged period with loads higher than 26,000 MW would result in a system that is both less reliable and has higher costs to the customer.

5.3 Limitations Of The Transmission System

Reliable and economic electricity supply requires a strong transmission system to move electricity from the generating units to the users. Operating generation economically can produce large variations in power flow on the transmission system with the maximum flows not necessarily coincident with peak load periods. For example, much of the generation in northern Ontario is peaking hydro. As a result, over peak load periods, the northern loads are all supplied from these local resources, leaving little, if any, power flow on the transmission lines connecting the south and the north. However, at other times, when the peaking units are shut down to allow replenishment of the reservoirs, most of the demand in the north is supplied by electricity flowing from south to north. For economical operation of the system, the transmission system must be capable of handling these wide ranges of flow patterns.

In addition to the more obvious situation where a load area cannot be reliably supplied because of inadequate transmission into that area, eg, the Ottawa area, there are other circumstances where inadequate transmission will be a problem. Inadequate transmission can lead to a situation where economic generation cannot be delivered from the generating station to meet peoples' needs. This can lead to an increase in generating costs. The present inadequate transmission connecting the Bruce Nuclear Power Development to the system is an example of economic generation being 'locked-in' the station and is costing the people of Ontario about $100 million dollars per year until this transmission deficiency is removed (see Section 2.4.6). Inadequate transmission can also result in local uneconomic generation being used to supply electricity needs in a particular area because sufficient economic generation cannot be transmitted into the area. The existing transmission bottleneck into the London area is forcing Lambton generating units to be run even though more economic generation is available elsewhere.

5.4 Limiting Acid Gas Emissions

Ontario Hydro's fossil-fuelled generating stations emit sulphur dioxide and nitrogen oxides which contribute to acid rain. About 80% of the acid deposition in sensitive areas of Ontario is due to emissions from outside Ontario. Of the 20% due to Ontario emissions, at its peak less than one-quarter, or 5% of total deposition have been due to Ontario Hydro emissions. In the early 1980s, Ontario Hydro's emissions averaged about 500,000 tonnes/year. They are now dropping sharply. Starting in 1986 Ontario Hydro must meet an acid gas emission limit which drops in stages, by about 60%, to a limit of 215,000 tonnes/year in 1994.

To meet increased energy demands and the stringent acid gas emission regulations, Ontario Hydro plans to install further emission control measures on some of the large coal-fuelled units in the 1990s. It will also burn low to medium sulphur coal on other units. As an example of costs, a program to retrofit 12 scrubbers on major coal-fuelled units could require expenditures of several billion dollars by the end of the 1990's and could add up to 5% to rates.

The acid gas reduction program will be coordinated with our implementation of those demand management options that can reduce our reliance on coal-fired generation in the future. With such measures, up to 43 TW.h of fossil generated energy may be produced without exceeding the emission regulations. The expected coal-fired energy production by year 2000 is about 37 TW.h.

5.5 Hydraulic Energy Production

The amount of hydraulic energy production, in a given year, is very dependent on the availability of water resources in the year. Much of the variability in water resources is due to cyclic changes in the Great Lakes water levels. The hydraulic energy production in a good water year can exceed those in a poor water year by as much as 12 TW.h or one-third of the current hydraulic energy production. This in turn, will have a direct impact on the fuel mix of Ontario Hydro's energy production. As the nuclear stations are usually base-loaded, the reduction in hydraulic energy production in a dry year will have to be made up by coal and oil-fired generation and may require some purchases from the neighbouring utilities through our interconnections with them. These measures, with others to control emissions, would then result in increased production costs.

5.6 Import and Export

Ontario Hydro's bulk electricity system is connected with the North American power grid through transmission lines connected with the Michigan, New York, Manitoba and Quebec power systems. Ontario Hydro, like its neighbouring utilities, will have low cost surplus energy available from time to time on

a short-term basis. We will import economic energy when available from other utilities to reduce overall production costs. When we have surplus generating capability, we will attempt to export to other utilities and apply the profits to reducing the cost of electricity in Ontario. For example, Manitoba Hydro and Hydro-Quebec frequently have surplus hydraulic generation that can be used to displace higher cost coal-fired generation in Ontario, thus reducing our fuel costs. Similarly, Ontario Hydro often sells coal-fired generation to New York and Michigan to displace their fossil generation that is even more expensive.

During capacity deficient periods, power may have to be purchased, irrespective of economics to avoid interrupting customer loads. Emergency assistance from our neighbours is available in limited quantities during capacity deficient periods when unforeseen events such as loss of some generation occur. Emergency assistance from our neighbours reduces the need for dependable capacity in Ontario by 700 MW.

5.7 Summary

By 1993, Ontario Hydro will have a generating capability of 32,400 MW which will be able to meet a peak demand of about 26,000 MW and 159 TW.h of energy reliably. The system will consist of about 43% nuclear, 29% coal, 8% of oil and 20% hydraulic capacity. About 61% of the energy required would be generated by nuclear, 22% by hydro, 17% by coal and less than 1% by oil. The production mix is dependent on a number of system conditions such as transmission constraints, acid gas emission limits, availability of hydraulic resources, amount of import and export, and the performance of our generating units and transmission facilities.

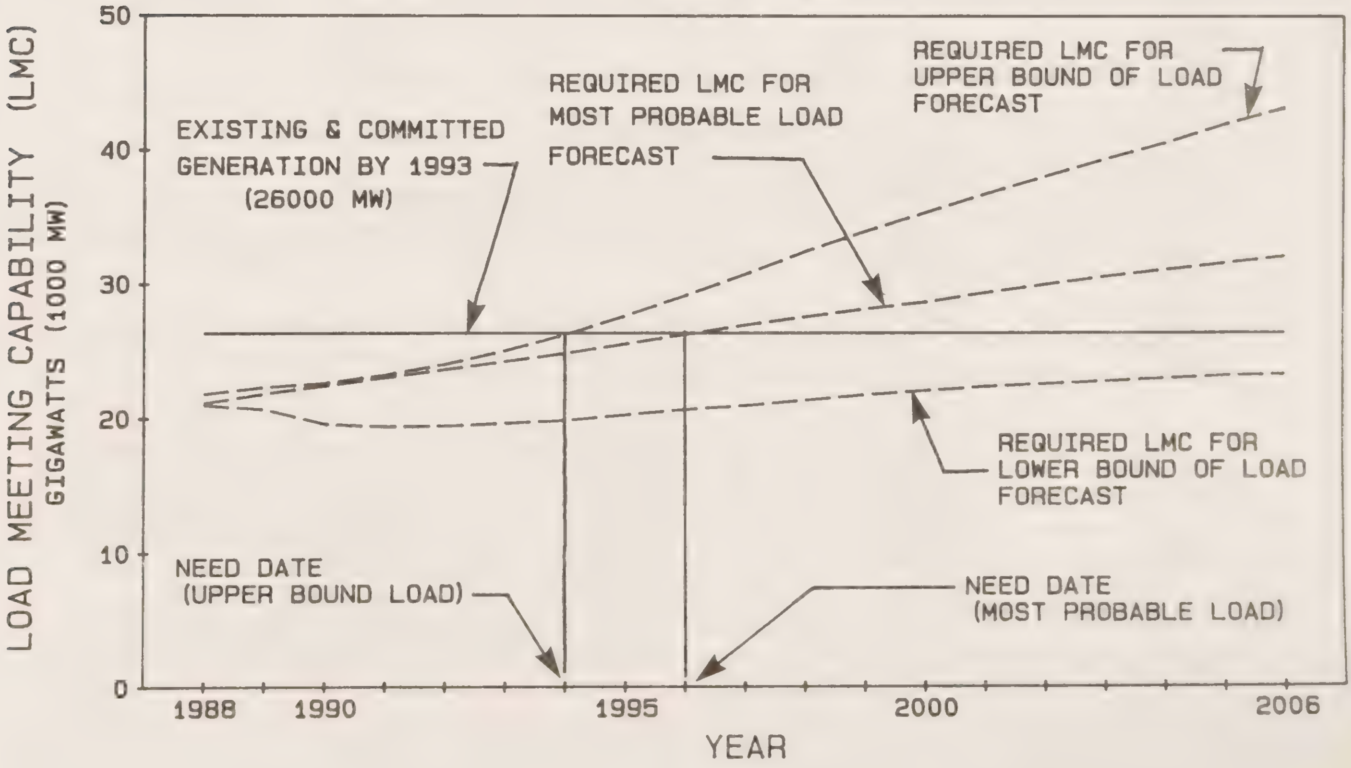
6.0 THE NEED FOR NEW DEMAND/SUPPLY RESOURCES

As noted in Chapter 5, Ontario Hydro's generating capability will be 32,400 MW by 1993. This generation can only be expected to meet a peak demand of about 26,000 MW reliably. With load growth as pictured in Chapter 4, new demand/supply resources will be needed to accommodate these new loads. For the development of scenarios, a growth rate of 2.4 percent per year is assumed in the most probable projection, and 4.3 percent and nearly zero percent per year for the upper and lower bounds of uncertainty respectively. Figure 6.1 shows when new demand or supply resources, over and above the existing and committed facilities less any retirements, are first needed to maintain adequate system reliability. Additional demand/supply resources would be required starting in 1996 with the most probable load projection and by 1994 for the upper bound. For the lower bound forecast, no additional resources would be required until after 2010.

With the most probable load projection the amount of additional demand and supply resources required would be an average of 710 MW a year; with the upper bound of the forecast, the requirement would be an average of about 1400 MW a year. These include the 24 percent allowance for reserve capacity.

Lead times necessary for obtaining approvals for, and putting in place, new demand/supply resources may dictate the options available to the system. For instance, the lead time for a major generating station is expected to be about a decade. Therefore, demand or supply options with shorter lead times would be required if needs for additions arise in the early 1990's.

FIGURE 6.1
NEED DATES



6.1 Amount Of Additional Demand and Supply Resources Needed

The amount of the additional electricity expected to be needed for various time periods and load growths is provided below. These needs are over and above the 26,000 MW that the existing and committed system can supply reliably.

Additional Electricity Needs

Cumulative Total Needs by	Lower Projection MW	Most Likely Growth MW	Upper Projection MW
1995	0	0	1800
2000	0	2600	9300
2005	0	5500	15900
2010	0	8000	22000

If the above electricity needs were to be met from supply options only, then an additional 24% allowance would have to be made to retain the 24% planning reserve requirement in order to meet the new electricity needs reliably.

For instance, to meet an increased need of 8,000 MW in the most likely load projection, the equivalent of about 10,000 MW or about five stations with four 500 MW generating units per station would be required by the year 2010. Since demand options would directly displace the increase in electricity needed, no reserve consideration is required. Therefore, the combined demand/supply resources needed would range between 8,000 and 10,000 MW.

6.2 The Aging Power System

Fossil plants are normally expected to remain operable for 30-40 years, nuclear plants for 40 years and hydraulic plants up to 80 years. Extending life beyond these times is possible, but will likely require significant capital expenditures to refurbish or replace aging components. This may not be economic compared to replacement with new demand/supply options.

Replacement or refurbishment of many existing generation facilities will be required by 2010. Otherwise, even more new demand/supply resources will have to be added to replace these aging plants.

Figure 6.2 shows the cumulative amount of generation exceeding its expected life at ten year intervals. By 2010, most fossil units will be over 30 years old. Lakeview and Lambton will be over 40 years old. Depending on the demand/supply options chosen, replacement or refurbishment of these facilities will likely be required by 2010. Although the study period terminates at the year 2010, it can be seen that there will be additional requirements to replace aging facilities in the 2011-2020 time period. This includes some nuclear units which will reach estimated 40 year useful life in this time period.

Figure 6.2 also shows that several hundred MW of hydraulic units will be over 80 years old by 2010. Ontario Hydro's resource plans assume that these units will be refurbished to make continuing use of a low cost, renewable Ontario resource.

Considerations of replacement or rehabilitation of old plant will become an increasingly large part of resources planning. Significant increases in operating and maintenance costs may have to be committed for the older stations before the end of their expected lives. For example, two of Pickering's nuclear units are being retubed after serving Ontario for about 12 years and hydraulic units over 75 years old will need major overhaul to maintain acceptable performance for the balance of their lives.

The replacement or refurbishment of existing generating facilities must be carefully planned to ensure that a reliable supply is maintained during the lengthy periods when they are taken out of service for rehabilitation work.

FIGURE 6.2
GENERATION EXCEEDING
EXPECTED USEFUL LIFE

6.3 Consequences of Not Adding New Demand/Supply Resources

System capacity reserve would decrease as demand continues to grow if no new demand/supply resources were added to the system. As a result, the reliability of electricity supply would deteriorate. Deterioration of system reliability would be noticed as longer and more frequent power interruptions, usually during peak periods.

As energy demand increases, there will be increasing amounts of energy that the existing and committed system cannot meet. In the most likely load growth case, this energy demand not satisfied would become apparent soon after 1996 and would increase to about 18 TW.h/annum or about 9% of system total energy demand by 2010. In the upper load growth case, it would become apparent soon after 1994 and increase to about 106 TW.h/annum or about 35% of system total energy demand by 2010.

6.3.1 Dependence on Coal and Oil-Fired Generation

Without any additional demand/supply options beyond the need dates illustrated in Figure 6.1, fossil-fuelled generating stations would supply the bulk of annual load increases because the hydraulic and nuclear-fuelled generation would already be fully utilized. Therefore, there will be an increased dependence on coal and oil-fuelled generation. It would be likely that higher operating cost fossil units, that are currently mothballed, would be brought back into service during the 1990s.

As described in Section 5.4, up to 43 TW.h could be supplied from fossil-fuelled generation assuming that emission control technology is installed and low to medium sulphur coal is burned at the other coal stations to respect acid gas emission regulations. Figure 6.3 shows that, with the most likely load growth, the 43 TW.h of fossil generation would be exceeded by the year 2002. Therefore, it would be necessary to implement more stringent acid gas control measures to permit increased fossil generation without exceeding the acid gas emission limit. The additional control measures could include retrofitting scrubbers to the smaller, and older, coal-fuelled units, burning even lower sulphur coals, or burning natural gas. These measures would be increasingly expensive per unit of sulphur dioxide removed. For example, the marginal cost of sulphur dioxide removal could increase from the range of $300-$500 per tonne removed to the range of $1000-$2000.

Figure 6.4 shows that, with the upper load growth, the same problem begins much earlier and additional acid gas control measures would be necessary by about 1995.

FIGURE 6.3

ENERGY FROM FOSSIL FUELS

MOST LIKELY GROWTH

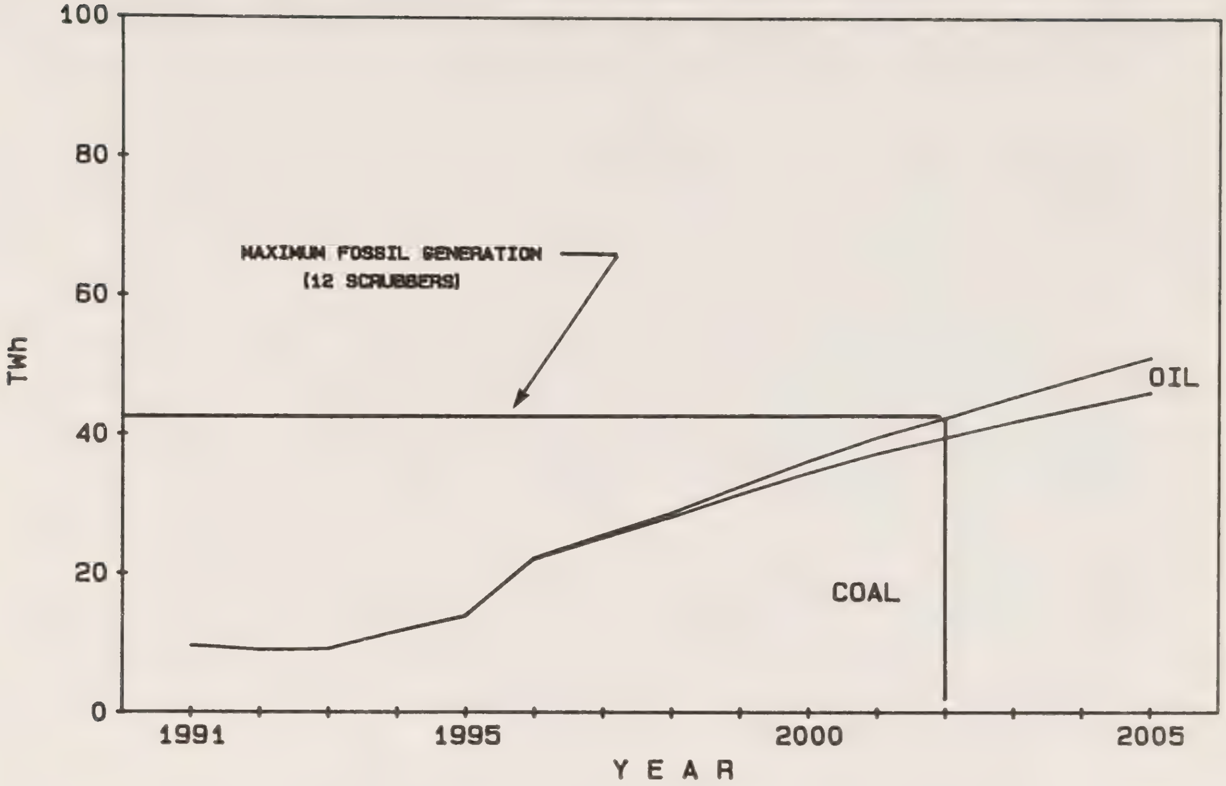
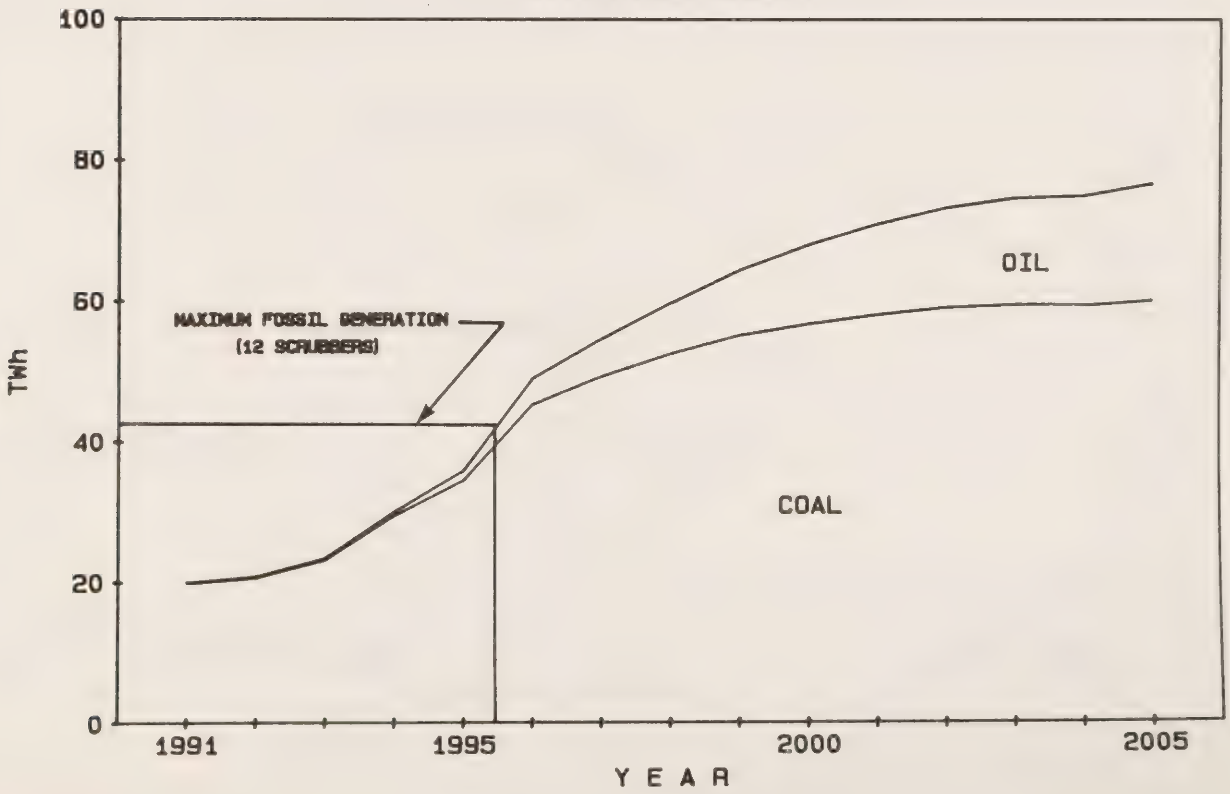


FIGURE 6.4

UPPER LOAD GROWTH

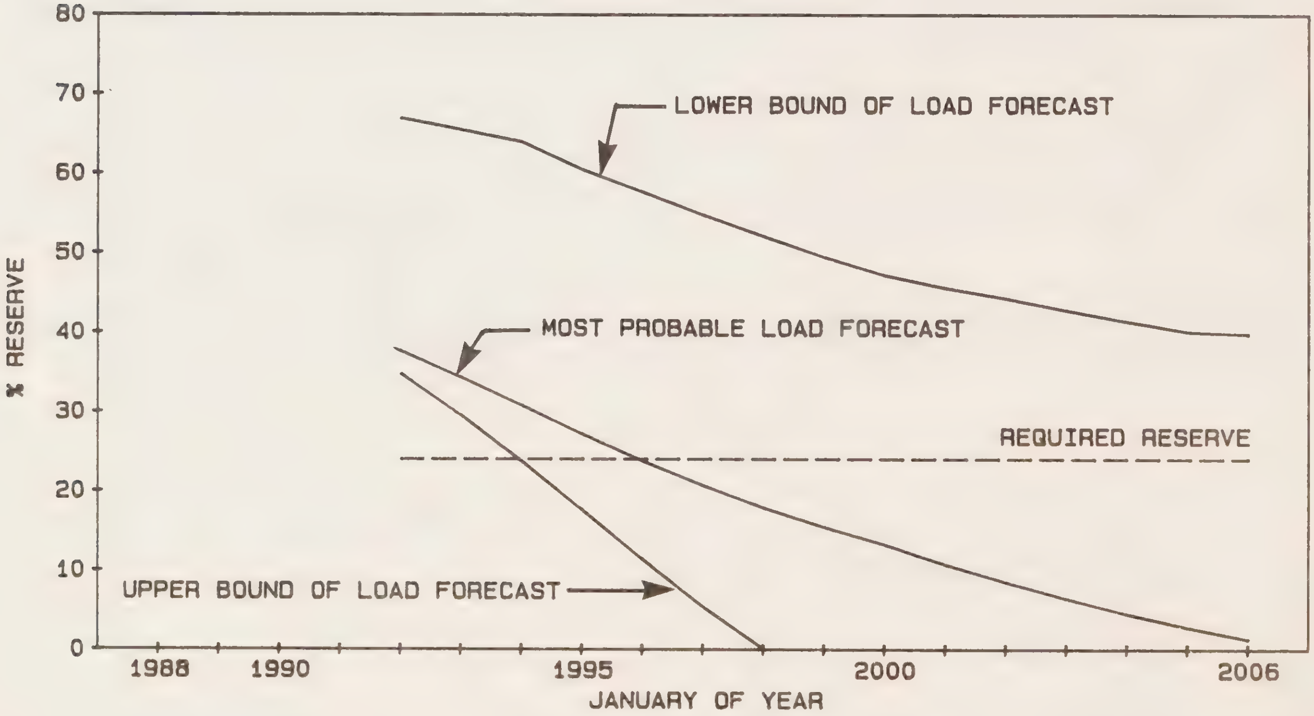


6.3.2 Deterioration of System Reliability

When system capacity reserve is lower than about 24%, the reliability of our power system will be lower than the planning criterion (see Section 2.3.1). System reliability can deteriorate rapidly as the reserve level drops below 20%.

Figure 6.5 shows how the percentage reserve margins decrease if no demand/supply measures are added to the system after Darlington. While the existing and committed generating system less the retirements may be adequate to meet the most probable load projection until about 1996, additional demand/supply resources could be needed as early as 1994 if the upper bound of the load projection were to materialize. By those times, demand for electricity would have grown to the point where normal reserve capacity to deal with unforeseen equipment breakdown or abnormally high demand would not be available. All generating capabilities including nuclear, hydraulic and fossil stations would be operated to their maximum potential within technical and regulatory constraints. Further increases in electricity demand could not be met when purchases from neighbouring utilities are exhausted. Consequently there would be increasing likelihood of not being able to meet the electricity demand of the people of Ontario. This would mean that some customers' loads could not be served during system peak load periods due to voltage reduction to lower demand, appeals to cut load voluntarily and even interrupting their connected loads. The frequency of these occurrences could be quite high, depending on the reserve margin of the power system; the risk of system-wide brown-outs and rotating load cuts would increase significantly.

FIGURE 6.5
CAPACITY RESERVE



The average generation system unreliability was about 3 system-minutes of unsupplied energy per year for the past 10 years. This is much better than our reliability target due to adequate system reserve capability. However, if the reserve level is allowed to drop significantly below the target level for extended periods, system reliability will deteriorate rapidly to the point that continuity of electricity supply cannot be guaranteed and new loads cannot be accepted. Therefore, industries that require reliable electricity supply may relocate to outside Ontario. This will impact on the economic well being of the Province in terms of employment, industrial growth and standard of living.

6.4 Summary

Additional demand/supply option resources will be needed to meet our customers' electricity needs by 1996 under the most probable load projection and about two years earlier for the upper bound of the load forecast. For the lower bound forecast, no new resources are needed before 2010. The amount of additional electricity likely to be needed is about 8000 MW for the most probable load projection and 22,000 MW for the upper bound forecast by 2010.

A large amount of our fossil-fired generation will need refurbishment by the year 2010. If this generation were retired instead, replacement facilities or demand reducing options would be needed to meet existing needs.

Significant deterioration of system reliability will result if no additional demand/supply option resource is installed to meet the increase in electricity need under the most probable load projection. The frequency in interrupting people's electricity use could increase significantly especially during system peak periods. System reliability probably will remain acceptable till 2010 under the low load projection.

7.0 CRITERIA USED TO EVALUATE OPTIONS

The comparison of individual demand and supply options or the evaluation of integrated plans requires looking at many factors. Even monetary cost has many different components, can be calculated in numerous ways, and may be viewed from several different perspectives. What follows is an outline of the major criteria used by Ontario Hydro in the evaluation process to decide how Ontario Hydro should proceed to meet its customers needs in an effective way. At the same time, provincial and/or federal governments may institute programs to further social, economic and energy policy objectives. Government programs have included building standards, the Canadian Oil Substitution Program, etc. The evaluation criteria used by government, will be somewhat different to those used by an electricity utility. While Ontario Hydro's planning will take into account government policy and programs, government programs are not the subject of this report and are not discussed further.

7.1 The Options Available Have Different Characteristics

Options have different abilities and characteristics to meet power requirements and also to meet energy requirements. Utility planners must ensure an integrated system has sufficient capability to meet the peak demand and also to meet the energy demands of customers reliably throughout the year.

Demand options have unique characteristics and are usually divided in two groups; load shifting and conservation. Load shifting options alter the times when electricity is required but do not change the total amount of electricity used. Load shifting options are an alternative to new generating plants and can reduce the use of oil, gas and low-efficiency coal plants. Conservation options reduce electric energy consumption by assisting customers to use electricity more efficiently. These replace new generating plant and reduce the total amount of fuel consumed.

On the supply side, Ontario Hydro's future options for additional generating plants can be divided into two main groups. Some, like hydraulic and nuclear, are expensive to build, but have low operating costs, and others, like oil and gas, are less costly to build, but expensive to operate. Most of the attractive hydraulic sites that are most economic to build and operate have already been developed. Coal plants have capital construction and operating fuelling costs that lie between these two extremes.

Because of this variation in cost characteristics utilities find a mix of various demand/supply resources results in least overall cost. Some of the resources are used to meet peak power demands but not for the daily base load energy requirements, while others are used for both peak power and base load energy requirements. High operating cost plants such as oil and gas, are used to meet infrequent peak demands. If they were used more often to meet our energy requirements, the price of electricity would rise. Similarly, new load shifting options are less useful after all the low fuel-cost plants are running continuously or when there is no longer a low-consumption period. Conservation, coal, nuclear or hydraulic options are used if the resource is primarily required to meet growing energy needs.

7.2 How Much Will the Option Cost?

The standard criterion used when looking at the direct costs is to choose the option or plan with the lowest cost. However, with integrated demand and supply planning, this simple statement must be clarified. There are many different costs and these are incurred by many different groups of people. In order to properly calculate the costs of individual demand or supply options or to calculate the costs of integrated plans, three questions must be considered - who incurs the costs?; what costs are included?; and how are costs compared?

7.2.1 Who Incurs the Costs?

The traditional division of responsibilities between electricity utilities and customers is that utilities are responsible for producing electricity and delivering it to the customers' premises while customers are responsible for how electricity is used, including the costs of the equipment and appliances that use it. This is consistent with supply planning but demand planning requires some adjustment to these roles.

With supply planning, if the utility chooses the lowest cost supply option, this will generally result in the lowest electricity rates over the option's lifetime and the costs will be distributed among customers in proportion to their electricity use.

Demand planning requires some modifications to the roles of utility and customer. In this case, the utility helps customers make changes to their electrical equipment and appliances. The utility may pay all or part of the costs of improved electricity efficiency that would traditionally have been the responsibility of the customer. In this case, it is necessary to decide an appropriate division of costs between the participating customer and the utility, recognizing that utility costs are passed on to all electricity customers including those who do not participate.

The result is that the costs and benefits will be shared differently between participating and non-participating customers. Participating customers will have costs for changes in their electricity equipment. These costs may be wholly or partly offset by utility incentives. In addition, for electricity efficiency options, the participating customer will benefit from lower electricity bills due to using less electricity. All customers, including those who do not participate, will pay for utility administration costs and incentives for demand management. In addition, all customers will benefit from the reduced cost of supply options due to implementing the demand options. The different division of costs between participants and non-participants can result in them preferring different options or plans.

Another effect of demand management programs is that they can cost less than supply programs, but at the same time, result in higher rates than if supply options were used. Because demand management programs usually result in less

electricity being used compared to supply programs, electricity rates (cost divided by use) will increase if a demand program is implemented instead of a supply program costing the same amount. Specifically, average rates over the life of an option will increase if lifetime demand management program costs to Hydro are more than supply program costs, less the reduced sales revenue. The highest amount a utility can pay for demand management programs before causing rates to rise is called the no-loser incentive level.

The rate increase with some demand programs means any customer who does not participate in the demand programs will pay more. At the same time, however, participants will still have lower electricity bills because they use less electricity. This illustrates that with demand programs some customers may receive more benefits than others.

An important concept with the changed utility and customer roles for demand planning is that of energy service, or more specifically, electricity service. Customers do not want or need energy for itself; they need energy for the services it can provide. Energy services that are often provided by electricity include light, motive power, heat, cooling and sound amplification. Provided the customer receives the electricity service he wants at low cost and with convenience and safety, his need has been met.

Figure 7.1 illustrates this concept for the electricity service of heating a house. The traditional utility costs are the production costs while customers have normally been responsible for the utilization costs. With demand planning, the utility becomes more interested in, and may contribute to the utilization costs. The utility activities extend beyond the provision of electricity to the provision of electricity service. Demand options can meet needs for electricity service with less electricity by improving the efficiency of the customers' electricity utilization equipment.

EXAMPLE OF TOTAL CUSTOMER COST

ELECTRICITY SERVICE

WARM HOUSE

RESOURCES REQUIRED

ELECTRICITY SYSTEM
GENERATION FUEL
OPERATING RESOURCES
} PRODUCTION COSTS

HOUSEHOLD WIRING
HEATING EQUIPMENT
THERMAL ENVELOPE
} UTILIZATION COSTS

} TOTAL CUSTOMER COST OF ELECTRICITY SERVICE

FIGURE 7.1

As described above, the sharing of costs and benefits among customers depends on the options selected. This means that different customers will prefer different actions by Hydro. Non-participants in demand management programs want options that keep rates low which happens when Hydro pays small incentives up to the no-loser incentive level. Participants want large incentives because this increases their benefits even though non-participants pay for the larger incentives through higher rates. The cost to produce electricity is lowest if Hydro pays moderate incentives up to what it would pay for supply options. This will result in higher rates and having participants pay as large a portion of demand program costs as possible. The cost to provide electrical service is minimized if what Hydro spends plus what participants spend is less than what Hydro would pay for a supply option. This is called the marginal cost criterion and it results in the lowest cost when all customers are added together.

All of these perspectives have some validity, but all result in different total costs of demand management programs and they may result in different decisions. When comparing options or evaluating plans, all perspectives and objectives should be considered. It must also be remembered that these are only the monetary costs. Other costs and benefits listed in other sections of this chapter are also important.

7.2.2 What Costs Are Included?

There are a number of main categories into which costs are traditionally grouped. These groups are described below.

Design, Construction and Acquisition Costs: Both demand and supply programs require large expenditures to implement them. These costs incurred before and during construction or acquisition are called capital costs and are recovered through rates over the lifetime of the resource. Demand management programs may have some of these costs paid by program participants.

Transmission and Distribution Costs: The addition of centralized supply options usually requires the development of more transmission and distribution facilities to get the power to the customer. Development of these facilities may be less extensive for options such as cogeneration and conservation because these provide electricity closer to the customer. The associated cost for transmission and distribution facilities must be included when evaluating options or plans.

The electricity lost in the transmission and distribution process must also be considered through its effects on this and all other cost components.

Financing Costs: The cost of borrowing money is an important component in the cost of any capital-intensive option. All cost evaluations account for this by using appropriate discount and escalation rates.

The Cost of Fuel: The cost of fuel for the generation of electricity depends on two factors: first, the primary cost of fuel (oil, gas, coal, uranium or water rental); second, the efficiency of converting the fuel into electricity (this ranges from 30 percent for a nuclear station up to 70 to 80 percent for a cogenerating plant).

Some options require existing generation to use more fuel. New loads, if similar to existing loads, will have an average demand throughout the year of about 67% of the winter peak demand. If demand options selected to reduce the peak demand have a much lower (less than 67%) effect on average demand, the existing generation will have to meet increased loads during off-peak times. The same effect occurs if supply options are chosen with low average energy production capabilities. This effect must be considered when comparing potential new resources.

Cost of Measures to Mitigate Environmental Impacts: Hydro has always realized many of its activities can have adverse effects on the environment. And Hydro has always incurred costs to reduce these effects. The cost of these measures must be considered part of the cost of any option. For example, coal-fired generating stations require facilities to control particulate and other emissions and long channels to take cooling water far from shores to reduce adverse impacts of large changes to water temperatures.

Operation, Maintenance and Administration Costs: Over the life of a demand program or of a generating facility there are costs associated with keeping it running efficiently and safely. This would include allowances for occasional major repairs such as replacing the reactor pressure tubes in a nuclear plant. This cost of operation, maintenance and administration must be included in the cost of the option.

The Costs to Dispose of Wastes

A number of wastes are produced while generating electricity. Coal plants produce large quantities of ash; flue gas scrubbers may produce sludge; and nuclear wastes include used fuel which must be separated from the environment for a long time. The costs of disposing of wastes in an environmentally acceptable way are part of the costs included when evaluating options.

The Cost of Decommissioning

After a plant has completed its useful life, there will be costs involved in dismantling the plant and returning the site to other uses. This cost may be partially offset by the value of any materials recovered; for example, the heavy water in a nuclear plant is transportable and can be used again. The net decommissioning cost at the end of its useful life is included in the cost evaluations.

7.2.3 How Are Costs Compared?

When comparing individual options or when evaluating integrated plans, the main obstacles in finding comparable costs are the same. Some method is required to compare present costs to future costs and allowance must be made for differing lifetimes of the options. Several methods are possible for an initial comparison of options but most of these have inadequacies that preclude their use for evaluating integrated plans.

For the initial screening of demand and supply options, Ontario Hydro has adapted an approach called standard costing. The cost to meet a standardized increase in load is calculated for each option. This is expressed in $/MW.h per year to allow comparison between options with different capacities and lifetimes. A more detailed description of the calculation of standard cost is in Ontario Hydro Report 652SP.

Although standard costing will continue to be used for an initial comparison of options, it cannot be used as the technique for evaluating integrated plans. Standard costing considers only one option at a time and cannot consider how different options interact. A more general approach is also required that facilitates calculation of rate impacts and financing requirements.

The present value evaluation method is used to compare options or plans with different cash flows over a long period of time and facilitates calculation of other impacts. All costs that are estimated to occur during the option's life are converted to what they would cost in today's money and then added up to come up with a single cost called the net present value. Adjustments must be made so that options or plans are compared based on the same quantities of electricity produced or saved over the same time periods. Different options or plans are evaluated by comparing these net present values.

To illustrate the present value technique, the 1985 present value of Darlington's life cycle cost, is estimated to be 8.7 billion dollars. Notionally, this means that if we opened a bank account today and deposited 8.7 billion dollars, this account with interest earned would provide us with enough money to build the plant, operate it, fuel it, decommission it and dispose of its fuel wastes. At the end of the plant's life the balance in the account will have been reduced to zero after paying for all these items.

Extensions to this technique have been developed for analysis of representative plans with different amounts of demand energy management. This permits diverse options, such as coal generation, and residential insulation to be evaluated on a similar basis. The option with a lower present value per unit of electricity has lower costs in the long run.

Another method sometimes used to evaluate future plans is the payback period method. In this method, plans are compared based on how long it will take to recover an initial investment through operating savings. The options

with the shorter time to break even or the highest rate of return are preferred. This technique is used by companies to screen a large number of alternative investments and may have some application when deciding whether a customer will participate in a demand management program. However, it is inferior to standard costing for screening options because it ignores option characteristics and lifetime. It is also not appropriate for evaluating integrated plans because it ignores option lifetimes and additional savings accruing after the payback period.

7.3 How Are Hydro's Borrowings or Financial Position Affected?

The impact on the borrowing requirements and on the finances of the utility are of particular importance to Hydro and to the provincial government. Implementation of different options involves expenditures that vary in amount and timing. For example, building a coal-fired station requires large expenditures before the station even generates any electricity, whereas payment for independently generated power involves payments only as electricity is received. This means capital expenditures could be quite different for various options. This, in turn, will result in quite different impacts on borrowings by the corporation. The financial impacts of implementing options have to be evaluated carefully, and plans must be altered if they have an adverse impact on the corporation's financial integrity.

7.4 What is the Effect on Rates?

The utility customers start paying for the options acquired when the options start saving or generating electricity. Different options have quite different impacts on how much customers have to pay and when.

Options with a high initial cost and low operating cost (eg, nuclear or hydraulic) will have much different effects on rates than those with low initial and high operating costs (eg, combustion turbines). Due to high initial financial charges for interest and depreciation, a nuclear or hydraulic plant will require customers to initially pay considerably more than if a combustion turbine was placed in service. The picture reverses with time as the fuel cost for the combustion turbine increases at about the inflation rate; after a few years, the nuclear or hydraulic project will cost customers considerably less than if the same energy came from the combustion turbine.

A similar effect occurs with short-lived options. For example, thermal energy storage heating has a high initial cost and a long lifetime compared to efficient light bulbs which have a very short lifetime and low cost. Because light bulbs need frequent replacement at costs that rise at about the inflation rate, they have a pattern of expenses similar to combustion turbines.

Rate impact is important to customers because of the effect on the bills they must pay. It also alters the competitive position of electricity compared to other fuels and the financial position of Ontario Hydro.

7.5 What Impact Will the Option Have on the Provincial Economy?

Impact on the provincial economy is a particularly important concern of the government. Decisions by businesses to expand or locate in Ontario, and the competitive positions of those already here, are often influenced by the availability of low-cost, reliable electricity. The choice of options will determine to what extent electricity will help stimulate the growth of jobs and economic prosperity in Ontario.

The implementation of some options can also create jobs and cause indirect economic spin-offs. The demand/supply options which are best under this criterion are those which use materials or fuel found or processed in Ontario and employ in-province labour.

7.6 What Impact will the Option have on the Environment?

Hydro tries to keep any environmental impacts as small as possible. If not well managed, all of the options could conceivably have an unacceptable impact on the environment. Just as uncontrolled acid gas emissions from coal-fired plants can create unacceptable outdoor air conditions, the improper sealing of houses for conservation purposes can cause unhealthy indoor air conditions.

Effectively managing the potential environmental impact of an option means using control measures to lessen its harmful effects. Acid gas emissions can be controlled by applying scrubbers to reduce the sulphur content in the emissions. And in thermally sealed houses, positive ventilation with heat recovery devices will ensure that poor quality air is constantly replaced with clean air with a minimum loss of heat.

Hydro makes every effort to design options to minimize their environmental impacts but residual effects always exist. The costs of modifications such as those described above are included as part of the cost of the option. The remaining effects must be measured as accurately as possible and included in the comparison of options or evaluation of plans.

7.7 How Acceptable is the Option to the Public?

As a public corporation, Ontario Hydro must consider the public's attitude towards its decisions. In the past both demand and supply options have been revised or cancelled in response to public opinion. Time-of-use rates is a demand option that has had problems with public acceptability. When Ontario Hydro proposed this rate structure for 1983 rates, it was not implemented because of pressure from some groups who felt their bills would increase. On the supply side, public perceptions and misconceptions of the environmental and safety impact of nuclear energy reduce the acceptability of this option.

All supply options have a common public acceptance problem known by the acronym NIMBY, standing for 'not in my backyard'. When people use more electricity requiring Hydro to build new transmission lines or a new generating station, everyone insists it is better for Hydro to inconvenience someone else. Whoever eventually has the new facility built near them will be inconvenienced. This is not unique to Hydro and applies to any large facility. The problem is most acute with nuclear and coal stations but also occurs with all generation options and with installations like cogeneration and wind turbines.

Review and understanding of public acceptance issues are an integral part of Hydro's planning. Hydro conducts extensive public consultation on a regular basis. Before any new major supply project involving land acquisition and capital borrowing is implemented, government approvals are also required. These approval processes involve more public participation, usually through formal hearings.

7.8 Does This Option Contribute To Customer Satisfaction?

Customer satisfaction is paramount for Hydro. Customers demand a reliable, high quality product, good service and affordable prices. In the electricity business, high quality means a product that is safely delivered to the customer, at the time it is needed and with acceptable characteristics such as constant voltage and frequency.

Demand options raise some new issues relating to public acceptability. They can appear unfair if certain customers see others benefitting by participating in a demand management program while they are excluded for some reason. These non-participants see themselves giving money to Hydro through higher electricity bills so that Hydro can pay incentives to other customers who also get savings in lower electricity bills.

Time-of-use rates illustrate one way customers can be dissatisfied with how they are affected by Hydro's actions. When time-of-use rates are first implemented some customers will have bill increases because it actually is more expensive to serve them. These customers were paying less than they should have been under the previous rates. Because they are receiving bill increases, these customers will, quite naturally, be dissatisfied with time-of-use rates.

7.9 How Long Will it Take to Have the Option Ready to Serve Customers?

Lead times are long for most major demand and supply options. Options with shorter lead times are needed to provide flexibility. Currently, our mothballed plants provide a resource that can be brought into service in a short time to meet an increase in demand. But, this flexibility will disappear if these plants are again used to meet our daily electricity needs. When that happens, we will need other options with short lead times.

There are a few ways to create or improve options to aid flexibility. One method is to use demand options. These are useful for responding quickly because they begin to help meet our electricity needs as they are gradually implemented. However, demand options can only be implemented quickly if a great deal of preparatory work has been done. Another method is to reduce the lead time of some supply options with new construction methods.

7.10 Is The Option Flexible to Respond to Changing Circumstances?

The uncertainty of the future demand for electricity represents a major challenge for planners. Our forecasts range from a growth at the rate of around 0.6 percent to around 4.4 percent per year. We estimate that there is a 60 percent chance future demand will fall into this range. Even if future demand falls somewhere within this range, we still have a great deal of uncertainty. The difference between the high and low forecasts of growth may seem slight at less than 3 percent a year, but that difference stretched to the turn of the century is over 13,000 megawatts - a figure equivalent to six times the power produced on the Canadian side of the Niagara River.

How, then, can we plan for energy needs with all of this uncertainty? We can't, for the sake of simplicity, plan for the expected case and hope it materializes, nor can we aim for the high case on the logic that at least we can meet our needs no matter what happens. Planning to meet just the low case would be equally imprudent. We could be jeopardizing the quality of life and economic prosperity of this province. We must plan for the expected forecast, while allowing ourselves the flexibility to respond to the high and low forecasts. This can be done, in part, by selecting a combination of options to give the required flexibility.

Different options and plans have varying degrees of flexibility to respond to higher or lower growth rates. For example, options that can be accelerated or delayed without significant cost penalties are flexible. The flexibility inherent in different plans is an important aspect to consider when evaluating them.

7.11 How Secure is the Supply of Fuel?

Ontario has a greater control over electricity costs when the fuel used in the generation of electricity comes from Ontario. A large price increase or an interruption of supply can result in large increases in the cost of electricity or an inability to supply electricity demand. Both of these would create severe problems for our customers. For this reason an additional factor considered when evaluating plans is the security of the generation fuel used.

The price stability and supply dependability varies considerably between fuels. The prices of both oil and gas are controlled by economic forces outside of Ontario and have experienced large price swings in the past. Coal, which contributes significantly to Ontario's electricity supply, is

better than oil or gas but its price and security of supply are still largely outside of our control. On the other hand, adequate supplies of uranium exist in both Ontario and Saskatchewan, and the refining of the fuel and the fabrication of fuel bundles takes place in Ontario.

Water, the fuel for hydraulic generation, is a renewable, inexpensive, and reliable energy source. However, the best river sites for hydraulic generation were developed earlier this century. The shortage of other economic river sites limits the possibility of increasing the use of this option to decrease our use of less secure fuels.

Demand options usually use no fuel so there is no risk from fuel price increases or interruptions. They may, however, have a similar risk. With some demand programs a customer can stop participating or alter his/her consumption pattern such that the demand option is no longer effective. This is a demand program equivalent to a fuel disruption but may be more within our control than oil and gas supply for example.

7.12 Are There Business, Technical or Strategic Risks in Developing This Option?

Many more types of risks have still not been described. What if interest rates are higher or lower? What if coal prices are higher or lower? What if customers do not show acceptance for shifting their time of use? What if the technology does not perform as expected? These are just a few examples of the other uncertainties that must be addressed.

A challenge in planning is to first recognize and understand these risks and then formulate plans that can minimize their adverse impact. Once the uncertainties are defined, risk can be managed by choosing options that look good even if circumstances change, by diversifying options, and by taking insurance or contingency measures. All integrated plans must try to incorporate as many of these techniques as possible.

7.13 Conclusion

A large number of different criteria must be weighed when comparing demand and supply options or when evaluating integrated plans. All of these must also be viewed from the perspectives of demand management program participants and non-participants, the cost of producing electricity and the overall cost of providing electrical service. The range of costs that must be considered include design, construction and acquisition costs, the costs of associated transmission and distribution facilities, environmental impact control costs, operation and maintenance costs, waste disposal costs and decommissioning costs.

There are several ways of looking at costs and they each make sense in specific situations and for specific purposes. To account for costs occurring at different times integrated plans are compared using net present value calculations. To gauge customer acceptance of demand management programs estimates of their rate of return may also be used.

Other important considerations are customer satisfaction, reliability of supply, public acceptance, flexibility, and business risks. All of these diverse factors must be considered when deciding upon the combination of options which provides the greatest overall benefit to our customers.

8.0 THE OPTIONS

This chapter provides a very brief introduction to the demand and supply options under consideration. A wide range of feasible demand and supply options with commercial potential in Ontario has been studied and is included here for public review. Those readers who would like more information are encouraged to read the supplementary documents titled "The Options" and "Demand Management".

Evaluating the options does not mean choosing one or two and excluding others from consideration. A combination of demand and supply options will help us meet our electricity needs. Ontario Hydro continues to look at ways to help customers use electricity more efficiently. At present, the demand for electricity is met by a mix of generation that includes hydraulic, nuclear, coal, and smaller amounts of gas and oil. This diversity helps to minimize the consequences if a major problem develops with one type of generation. The mix also allows us to maximize the advantages and minimize the disadvantages of each generation type as described in Chapter 5.

The options are of four main types: options to reduce demand such as load shifting and efficiency improvements; smaller scale supply options including small hydraulic, cogeneration, wind, and solar; supply options such as hydraulic, nuclear, coal, gas and oil; and purchases from neighbouring utilities.

Demand options are designed to assist customers to use electricity more efficiently so that more electricity is available to meet new customer needs. If economic demand options cannot offset all of the growth in demand for electricity, then new supply options will be necessary to increase the amount of electricity available to our customers.

However, growing customer demand is not the only condition that needs to be satisfied. As existing stations approach the end of their useful lives, questions arise concerning their replacement. Can economic demand options eliminate the need to replace the station? Is it more desirable to extend the life of the existing plant, redevelop the site with a new facility or start fresh with a new site?

8.1 A Brief Look at the Options

8.1.1 Demand Options

Demand options include a wide range of activities in which the utility works with the customers to help them shift or reduce their demand for electricity while still providing the service they desire.

Customers have been taking steps to lower their electricity bills by using electricity more efficiently throughout the history of the electricity industry. Because we expect customers to continue improving the efficiency of electricity use, a provision for these natural conservation activities is

included in the load forecast. However, further reductions in the peak demand for electricity can be accomplished through load shifting and utility sponsored programs to improve efficiency. These measures require the active participation of Ontario Hydro, the municipal utilities, governments and customers. Success will require a high degree of cooperation.

The experience of U.S. utilities has shown that successful demand management programs require careful research and demonstration. Demand options take time to develop and implement. They require several years for data gathering, market development, and program design. Once full scale implementation starts, it can take up to a decade to fully penetrate the market.

Although rates can be a very effective tool for demand management, rate changes require careful consideration of many issues such as ensuring that costs are allocated among customers in a fair way. This and other rate making issues are addressed in the supplementary report, "Rates as a Demand Management Tool".

Load shifting options give customers the incentive to reduce their consumption of electricity during peak periods by shifting their consumption to non-peak periods. Load shifting options help decrease the supply of electricity required during peak periods, but do not decrease the overall need for energy. Loads can be shifted either through "direct" controls on equipment such as water heaters or through "indirect" rate incentives. Time-of-use rates give industries the incentive to shift their production activities to off-peak hours. Residential customers could purchase heat storage furnaces or storage hot water heaters which store heat overnight and release it during the day. Incentives could be provided to these customers indirectly through time-of-use rates or through direct rebates for the purchase of such equipment. Although these customers reduce their demand for electricity at peak periods, their demand for energy must be met at other times.

Efficiency improvements in the way we use electricity can slow down the rate at which Ontario Hydro needs to build new generating facilities. Education and information programs along with energy audits can make customers aware of the opportunities. However, since utility programs are intended to concentrate on activities that will not happen naturally, customer participation will likely require incentives. The customer will benefit in the long run, but needs some immediate incentive to spend money on insulation, ventilation, high efficiency appliances and other conservation measures. Ontario Hydro can offer various kinds of financial assistance where it is cheaper to pay customers to conserve electricity rather than to pay for a new generating facility. However, some of the costs may have an indirect impact. For example, the cost of energy efficient houses could be reflected in higher house prices.

Since demand options are being considered as alternatives to building new sources of supply, it would seem reasonable to proceed with them only when new supply of electricity is needed. However, early development of some demand options may give opportunities to save energy now that will be more expensive, or even unavailable, at a later date. For example, it is less costly to build efficiency into a new building or when a building is being renovated than it is to retrofit to improve efficiency.

Not all conservation opportunities will help us reduce demand in the winter when we need it most. For example, improved air conditioners will help off-set demand in the summer but would not help to satisfy a growth in demand during the peak winter period. Although they reduce the overall energy requirement, they do not reduce the amount of generating capacity required to meet peak electricity needs.

There may be situations where energy efficiency standards are justified. However, most people do not want demand management to be mandatory because it may restrict their freedom of choice or lifestyle. The development of mandatory energy efficiency standards must take into account the full range of interests that are affected. Since the range of interests goes far beyond the concerns of an electrical utility, standards are best set by agencies such as governments. The use of standards is discussed in the supplementary document, Demand Management.

There are other barriers to implementing economic or socially desirable electrical efficiency measures that may not be adequately addressed by research, information programs, changes to rate structures, financial incentives or standards. Some of these barriers may be known, for example, the lack of incentive for tenants to save electricity in bulk metered apartments. There may also be other barriers that will be identified in the future, in the course of market development programs. The reduction or elimination of these barriers will, in most cases, require a cooperative effort by Ontario Hydro and other interested parties.

Like some of the supply options, demand management can have a relatively high Ontario content. The labour for installation of efficiency improvements will be within the province and widely distributed. In addition, since Ontario has a large manufacturing industry, most of the more efficient equipment could be made within the Province, but it may take local companies some time to adjust product lines.

8.1.2 Alternative Technologies

Photovoltaic cells, wind generation, small hydro, industrial cogeneration and the burning of municipal solid waste are some of the alternates that have been evaluated. Utilities in other areas have implemented some of these alternates as substitutes for high cost oil and gas generation. Many of these alternates are not economically viable at the present time since Ontario does not depend to a significant degree on oil or gas. However, there are situations in which some of the alternates can compete economically. For example, although limited in quantity, cogeneration from waste can be competitive. In addition, wind generation could replace some of the energy produced from costly diesel-fuelled generation in remote northern communities, which are not connected to Ontario's transmission system.

In many cases these options will be owned and/or operated by others while some may be utility controlled. The issue of ownership requires special consideration. For this reason, later chapters of the report will deal with alternative technologies under two different headings. Utility-owned generation will be considered under "Alternative Generation", while privately-owned generation will be discussed under "Independent Generation".

Most independent generators use the power generated to supply part of their own electricity needs. However, some independent generators wish to sell all or part of their generation to Ontario Hydro or the municipal utilities. Ontario Hydro sets rates at which this electricity will be purchased based on "avoided cost", which is the value of the power to Ontario Hydro. The avoided cost may vary according to the timing, location and degree of dependability of the delivery.

There may be specific cases where the system wide rates based on avoided cost fail to give sufficient incentive to develop independent generation that can contribute to meeting our customers' needs for electricity service. For example, a remote location where costs of other alternatives are unusually high is such a case. To determine whether or not additional payments are justified requires an examination of the type of generation and under what conditions it is produced. If additional payments are justified then these can take the form of increased rates, loans or grants.

8.1.3 Supply Options

Existing generating facilities will be the most important category of generating plant over the 20 year planning period. They will be the backbone of the electricity supply system. Improvements at existing plant can reduce the need for new generating plant.

As existing units age, they require new expenditures to prevent them from becoming unsafe, uneconomic, environmentally unacceptable, unreliable, etc. The alternative would be to shut down the facilities, but it is frequently more economic to rehabilitate or redevelop old generating plants than to build new replacements.

Sometimes a plant reaches a point where continued operation is unacceptable and rehabilitation or redevelopment does not seem worthwhile; it would be more economic to replace it with cost effective new plant. However, old plant may still have value to provide flexibility to cover uncertainties in future load growth. If the load grows too quickly, old plants may be the only way to maintain reliability, even though they are expensive to operate.

However, improvements and redevelopments of existing plants are site specific and they do not lend themselves to generalizations. The options briefly described below refer to new facilities. The emphasis is on availability of fuel, key environmental concerns as well as any other major planning considerations specific to the options.

(a) Hydraulic: Relative to other supply options, hydraulic plants tend to be expensive to build and inexpensive to operate. Most of the more economically attractive and less environmentally damaging sites have already been developed. However, as a safe, proven technology using a renewable energy source, hydraulic generation continues to be an attractive option. Environmental concerns relate to flooding of land, changes in river flows and the need for transmission lines. Although all supply options require transmission lines to connect them to Ontario's electrical system, hydraulic sites are often in remote locations and therefore require longer lines. The scarcity of viable, undeveloped sites will limit the role further hydraulic generation can play in Ontario.

(b) Nuclear: For large scale, economical electricity, nuclear power has proven to be a successful option. Like hydraulic generation, nuclear plants are expensive to build but inexpensive to fuel. Nuclear, unlike hydraulic, has relatively high requirements for operating staff but this does not eliminate the economic advantage. Some elements of nuclear costs have large uncertainties (eg, decommissioning and used fuel waste disposal), because these activities have not yet been done on a large scale. However, these represent small parts of the total costs and nuclear energy would remain a low cost supply option even if these costs are substantially underestimated.

High quality supplies of uranium are available in Saskatchewan while Ontario has abundant lower quality resources. Since most of the CANDU technology and the industry to develop it, resides in Ontario, nuclear energy can have significant benefits for the provincial economy.

At present, the nuclear industry depends heavily on Ontario Hydro as a market for its technology. The impact that planning decisions can have on the viability of the industry is a major concern.

In addition, public concerns about safety, decommissioning and waste disposal, along with the long lead-times associated with approvals and construction remain key issues. Some of these issues are being addressed by the commission on Ontario Nuclear Safety Review (ONSR). This commission was established by the provincial Ministry of Energy in December 1986, in response to a recommendation made by the Select Committee on Energy (Final Report on Toward a Balanced Electricity System, July 1986). The ONSR commission is due to submit its report by the end of February 1988. Current government policy and future government plans might be affected by the outcome of this review.

(c) Coal: Coal-fired generating plants are generally less expensive to build than nuclear plants, but significantly more expensive to operate. The fuel is in plentiful supply, although Ontario must purchase its requirements from western Canada or the United States (Chapter 3). Coal continues to be a viable option largely because of new technologies that can reduce acid gas emissions. Many existing plants will have to be modified with desulphurization scrubbers, in order to meet the tighter acid gas control standards required in the 1990s. New plants would require even greater control on emissions. However, some of the emission control devices and the new plant designs such as integrated

gasification combined cycle (IGCC) are not yet fully proven for the size of plants that may be required. Whatever technology is used, coal-fired generation will have to meet the environmental regulations.

(d) Oil and Gas: Similar to coal-fired stations, oil and gas-fuelled stations are less expensive to build but considerably more expensive to operate. Both fuels are generally considered scarce resources (Chapter 3). Although prices dropped significantly in 1986, they are expected to rise over the next 10 to 20 years. Like coal, the combustion of oil and gas can contribute to acid gas emissions. Nevertheless, oil and natural gas generation may still have a role to play in meeting short duration peaks in demand for electricity.

(e) Energy Storage Technologies: These technologies can make more effective use of existing generating capacity. At night, coal-fired plants are used at less than full capacity. Additional energy from these plants could be stored in a battery or in a reservoir of water. When the stored energy is released the next day, we shift electricity production capability to high demand periods. Energy storage technologies could help meet our peak demand requirements, but would not contribute to our overall energy requirements. In fact, they are net energy consumers because the electricity required to build up the store exceeds the electricity generated when the store is released.

8.1.4 Purchases

Negotiations with Manitoba and Quebec for long term firm purchases of electricity began in early 1985. These have resulted in a short term firm contract with Manitoba for Ontario Hydro to purchase 200 MW for a five year period, beginning in 1998. Negotiations for long term firm purchases are continuing. In this report, the analysis of purchase options considers a range of possibilities as amounts and prices are subject to negotiation.

Ontario Hydro will not be able to purchase large quantities of electricity from existing generating facilities. Neither Quebec nor Manitoba expect to have a capacity surplus in the 1990s. Therefore, a large long term purchase by Ontario Hydro means that the selling province will have to construct new hydraulic stations and extensive transmission facilities.

(a) Manitoba: The Conawapa site located on the Nelson River in northern Manitoba is the most likely site that would be developed for the sale to Ontario. Purchases of 200 MW, 500 MW and up to about 1000 MW for up to 35 years are being considered. All but the 200 MW option would require earlier construction of new transmission facilities in Ontario.

(b) Quebec: Purchases from Quebec would require the development of hydraulic plant in northern Quebec. One project could include the area drained by the Nottaway, Broadback and Rupert rivers (the NBR Complex). Another project could be 300 km further north on the Le Grande River near the existing James Bay Project. A third project could be 250 km still further north on the Grande Baleine River. Purchases of about 750 MW, 2000 MW and as high as 4000 MW for up to 30 years are being considered. All but the 750 MW option would require major new transmission facilities in Ontario.

8.2 Average Lifetime Energy costs

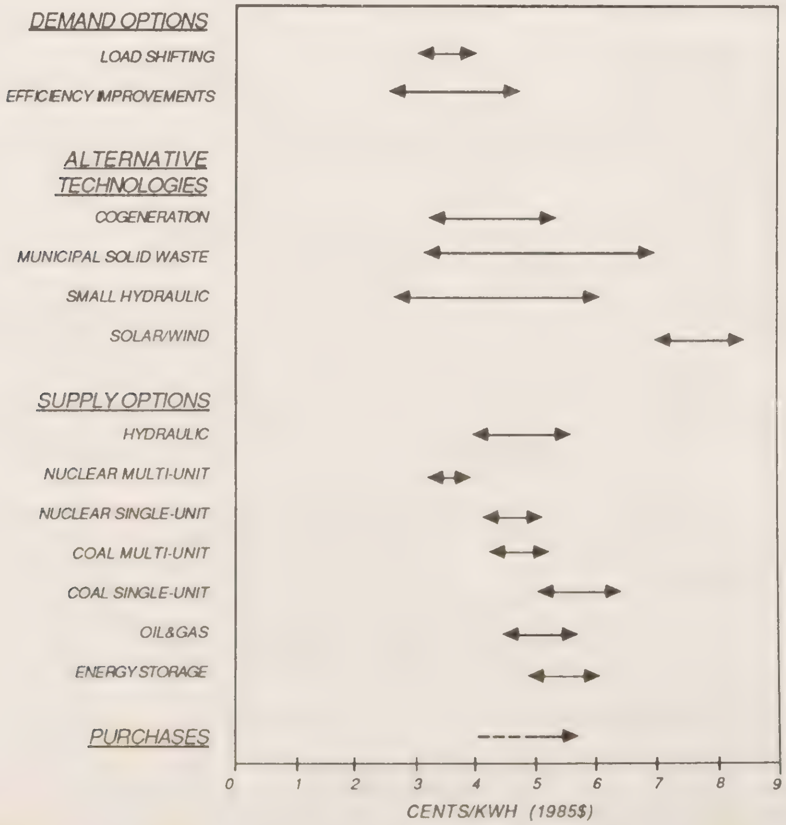
The remaining sections in this chapter will compare both demand and supply options. However, the options being evaluated have quite different characteristics. Some can only operate for short periods while others can operate all year long. Some have the flexibility to be started up and operated when they are needed while others do not have that flexibility. Some have long lives while others may only last a few years. Some have high capital costs while others are costly to operate. As described in the previous chapter, these and many other factors must be considered when evaluating the average cost of the energy produced by each option over its lifetime.

At present, we are able to identify a range of lifetime energy costs associated with each of the options (see Figure 8.1). These ranges represent a variety of options in each category; they do not represent uncertainty ranges. Thus, not all of the potential is available at the minimum cost.

For example, the demand options of load shifting and efficiency improvements actually represent a large number of specific activities to help our customers change the pattern or efficiency of their electricity use. Therefore, demand management programs will include a number of options ranging from those that cost less than supply alternatives up to those that are comparable in cost.

Further information on the lifetime energy costs for each option and the "standard cost" method used to calculate them are given in the supplementary document, The Options.

Figure 8.1
AVERAGE LIFETIME ENERGY COST

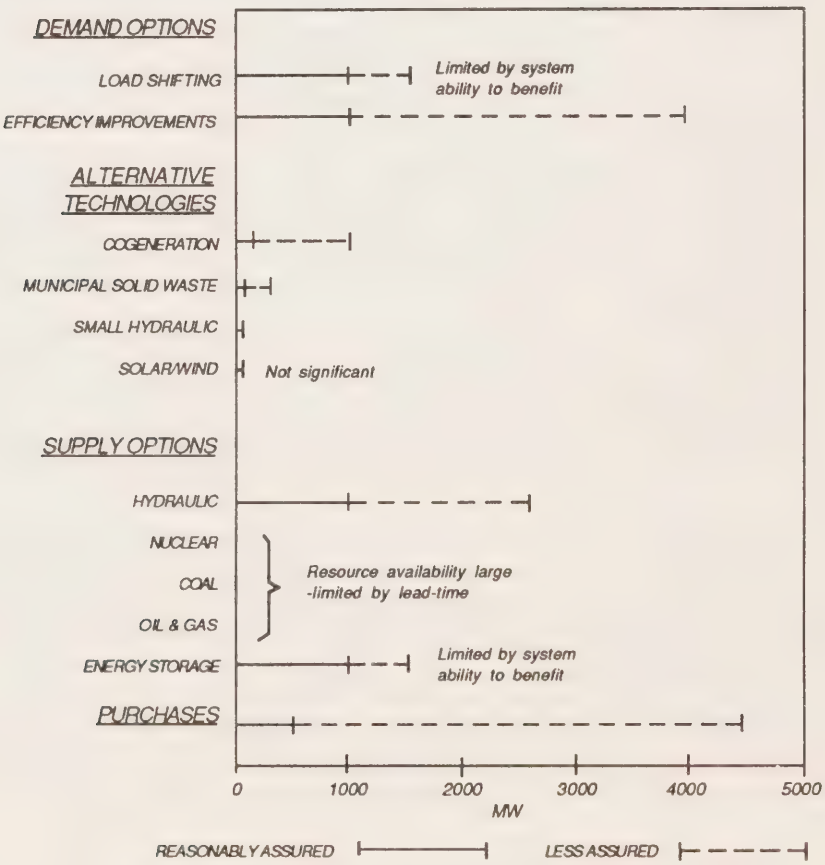


In some cases, such as small hydraulic and cogeneration, the costs depend on the site or on whether or not waste fuel is available so the range of costs is wide. In other cases, such as nuclear and coal, the technology is well defined and so, although there are significant uncertainties, the range of costs is relatively small compared to options that encompass a range of opportunities with varying costs. The economies of scale resulting from building more than one generating unit at one site (ie, multi-unit stations) are illustrated for the nuclear and coal options. The costs of single unit stations are substantially higher and so their costs have been shown separately. The cost of purchases depends upon negotiations which are influenced by market conditions; the price other purchasers are willing to pay. Consideration of two recently announced transactions suggest both the price and range of prices are increasing.

8.3 Potential Contributions to Power Requirements

In terms of planning for the future, cost is only one consideration. It is also important to know how much generating capacity (MW) can be acquired by the time we may need it. Figure 8.2 compares the potential contribution that each option could make to satisfying the growth in the system's peak demand by the year 2000. The potential is divided into that which is reasonably assured and that which is less certain. The potential is generally limited by either how much is available at a competitive price or how much can be built in the time available.

Figure 8.2
POTENTIAL CONTRIBUTION TO POWER REQUIREMENTS BY THE YEAR 2000



Demand reduction depends on how many efficiency improvements can be made, as well as what level of incentive is offered and how receptive the customers are to Ontario Hydro programs.

Hydraulic and the alternative technologies, such as cogeneration and municipal solid waste, have relatively short lead-times but are limited by the number of sites that are economic.

The contribution to capacity needs by the year 2000 from the traditional thermal supply options of nuclear, coal, oil and gas are unlikely to be restricted by the availability of energy resources. With the possible exception of oil and gas, these resources are also reasonably economic. The primary limit on the contribution of these technologies to capacity by the end of the century is lead time. Even if they were the preferred option, the time required to gain approval and then design and construct, is in the order of a decade or more. This lead time is likely to limit the amount that could be built by the year 2000. If approval were granted in adequate time, then 1000 MW per year would be a reasonable capability in the post 2000 period. This would be comparable to the rate of construction actually achieved in the 1970s.

Load shifting and energy storage options are limited by how much the peak demand for electricity can be shifted before the load becomes flat throughout the day and night. Our estimate is that 1000 to 1500 MW of load shifting may be useful for flattening load by the year 2000. Since customer load shifting and centralized energy storage options satisfy the same need, it appears that the lower cost demand-side options may be more desirable.

The potential for purchases is based on the range of 500 to 4500 MW under consideration. The upper end of this range would require an early commitment by Ontario Hydro and an aggressive construction effort by Manitoba and Quebec. Therefore, 4500 MW is likely to be the maximum amount of purchase by the year 2000.

8.4 Lead Times and Flexibility

As discussed in Section 8.3, long lead-times can restrict the supply systems ability to respond to changing conditions.

The demand options clearly have the shortest amount of time elapsing between when money is spent and when the benefits begin to show up in reduced demand for electricity. However, the time required to get large quantities of conservation can be similar to the time required to build a new generating station. Therefore, to ensure a reliable supply of electricity, demand programs have to begin well before the need arises. However, once the programs are in place, demand programs have considerable flexibility to match the growth in demand for electricity.

On the supply side, the long construction times and lengthy approvals process mean that authorization for new facilities is necessary before the need can be demonstrated with certainty. Although construction schedules can be modified in response to changing forecasts of the demand for electricity, the benefits associated with money spent during construction do not appear until the station goes into service.

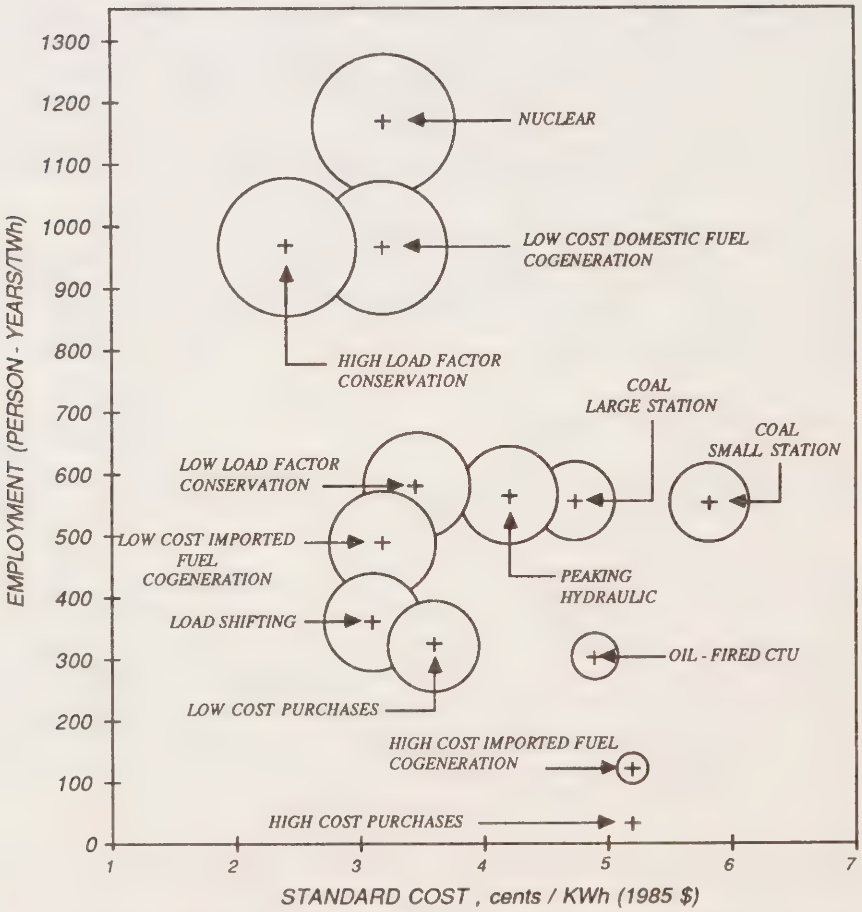
8.5 Benefits to the Ontario Economy

A number of demand and supply options are looked at in terms of their potential impact on the provincial economy. The options are evaluated for their effects on real gross provincial product (GPP) and their ability to create jobs. Their relative impact is illustrated in Figure 8.3.

Generally, the best options are those that have low lifetime costs and relatively high Ontario content in their installation and/or operation and fuelling of the options. These include nuclear, conservation in applications that operate most of the time (i.e. high load factors), and cogeneration at sites that use low-cost indigenous fuels such as waste products. As the costs go up or the amount of Ontario content goes down, the value to the Provincial economy is reduced.

Figure 8.3

RELATIVE ECONOMIC IMPACT



Areas of circles denote the impact on GPP (per KWh) relative to high cost purchases. Larger circles denote more desirable options.

9. PUBLIC AND GOVERNMENT CONSULTATION

Ontario Hydro's Public Consultation Program is an integral part of the Demand/Supply Options Study. The program was designed to identify the opinions, concerns and priorities of customers, individuals and organizations throughout the province regarding future energy needs and options. A brief description of the program elements, a summary of the key findings, and implications for strategy are presented in this chapter.

Views expressed by program participants are summarized without evaluation of their factual accuracy or consistency with other information sources.

This chapter also includes a brief description of consultation with government ministries and key findings of the Select Committee on Energy regarding the Demand/Supply Options Study.

9.1 Elements of Hydro's Consultation Program

Hydro is using a range of consultation approaches to inform the public about the study and to provide opportunities for a variety of people to become involved (see Figure 9-1). Background research, focus groups, field tests, reviews of survey results and discussions with other utilities and consultants were undertaken in the development of consultation and communication programs.

The consultation efforts provide the opportunity for personal exchanges of information between the public and Hydro's senior management. Communication activities are designed to make information on the study and the range of options available to many people.

The Provincial Organizations Consultation Program has been developed for groups who may be interested or affected by Hydro's plans for meeting future energy needs. Of 125 organizations invited to participate in a series of five meetings in Toronto between November 1985 and February 1986, 58 accepted. Each meeting consisted of a short presentation by a Hydro senior executive and a discussion of opinions, concerns, and priorities about the options and the study process. In response to Hydro's request, 36 written submissions, from one page letters to submissions over 50 pages were received. Hydro provided written replies to each of these submissions.

The Regional Consultation program was focused on community leaders active in public affairs across the province. There were 13 meetings held between January and June of 1986, in Sarnia, Chatham, London, Hamilton, Port Hope, Kingston, Winchester, Alliston, Bracebridge, North Bay, Sudbury, Timmins and Atikokan. More than 300 attended the meetings.

NOTE: All people who took part in the program are referred to as participants, including those involved in the market survey.

Figure 9.1
Public Consultation Program

Elements	Public Involved	Activity	Number of Participants
Provincial Organizations	58 organizations	5 meetings 36 briefs	58*
Regional	13 communities	13 meetings questionnaire	300
Municipal Utilities	116 utilities	10 meetings	300
Market Survey	residential, industrial, and commercial customers	questionnaire	1,200 residential 200 industrial 200 commercial
Government	Provincial and Federal Ministries and Select Committee	briefings, submissions and testimony	

*Provincial organizations participants represented their memberships.

Generally, between 15 and 30 representatives from various segments of the community were at each meeting.

The Municipal Utility Consultation Program was focused on the managers and commissioners of the province's municipal utilities. About 300 representatives from 116 municipal organizations attended the ten sessions held between February and June, 1986. In addition to these discussions with Hydro management and planning staff, a liaison committee of representatives of the Municipal Electric Association and senior Hydro executives was proposed.

The values, attitudes, and opinions of Hydro's residential, commercial, and industrial customers were sought through a market survey undertaken by Goldfarb Consultants in January and February, 1986. Home or plant interviews were carried out with 1,200 residential, 200 commercial, and 200 industrial customers.

The details of these Consultation Programs are described in the following reference documents: Provincial Organization Consultation Program Report SCS86002/1-3; Regional Consultation Program Report SCS86003; Municipal Utilities Consultation Report SCS86004; and the Goldfarb Market Survey Report.

Ontario Hydro regularly keeps the Ontario and, as appropriate, federal governments, fully advised of significant planning activities which might result in additions to the bulk power system, or activities affecting power customers. In particular, the Ontario Government's interest in these and other Hydro-related areas underscores its responsibility for developing and implementing energy policy for the province, and its responsibilities as detailed in the Power Corporation Act, Environmental Assessment Act and other legislation affecting Hydro.

In the case of Hydro's Demand/Supply Options Study, the Corporation has met with provincial government ministries, and federal departments which might have an interest in the study, to acquaint them with the study's objectives, schedule and information on the options. At the same time, an all party provincial legislative committee reviewed the study in detail.

The Select Committee on Energy was appointed on July 10, 1985 to "inquire into and report within ten months on Ontario Hydro Affairs." In its first session, 19 days of hearings were conducted in September and early October, 1985 during which the Committee examined the need for Darlington NGS.

The Committee held 12 days of hearings in its second session in April 1986. This session focused in general on Hydro's planning process and the delineation of operating and policy making responsibilities between Ontario Hydro and the Government. In particular, they focused on demand and supply options, Hydro's Demand/Supply Options Study and the process of choosing options. During this period the Committee heard from 64 witnesses including representatives from Hydro, filed 79 exhibits and received written

submissions from 17 public and interest groups.

Communication initiatives, a key element in Hydro's consultation program, were made to a broad range of audiences -- those involved in the consultation programs as well as those not directly involved, e.g. simulation program for secondary schools. Since August 1985, more than 25 speeches by Hydro executives to a wide range of audiences have focused on future energy needs. About 15 presentations have been given by other Hydro staff through Hydro's Speakers Bureau.

More than 1,000 copies of an 80-page document describing the planning process and the options were distributed to consultation program participants, government and individuals. A 16-page brochure was prepared and more than 43,000 copies were distributed to government, municipal and business leaders, educators, visitors to Hydro offices and information centres and senior Hydro staff. Eight-minute and three-minute audio-visual presentations were produced for use at public meetings, information centres and special events. A 27-minute video production was made available to cable TV companies. An exhibit on future energy needs was developed for community events and meetings.

A simulation game based on the Meeting Future Energy Needs Study was prepared for use in secondary schools. More than 2,000 students from 116 schools participated, culminating in a province-wide playoff in May 1986.

Section 9.2 summarizes the implications of the key findings of the consultation program for developing a strategy. Sections 9.3 to 9.10 provide additional information on the opinions, concerns and priorities expressed by program participants.

9.2 Strategy

Comments and opinions expressed by public consultation participants suggest that Hydro consider pursuing a strategy that:

- emphasizes the following priorities,

    - maintain reliability of supply
    - maintain reasonable rates
    - minimize environmental damage
    - encourage consumers to use electricity wisely and efficiently
    - ensure flexibility
    - use a diversity of energy resources
    - maximize public safety
    - constrain Hydro's borrowing and increases in debt
    - create jobs and economic benefits for Ontario
    - minimize lifestyle adjustments.

- emphasizes the use of indigenous resources -- this ensures security of supply and contributes to job creation and the economy.

- provides a range of choices for electricity consumers with the emphasis on voluntary rather than mandatory participation in demand management.

- to meet longer term needs emphasis on demand management before commitments are made to supply options.

- emphasizes smaller, more flexible supply options and hydraulic before large nuclear or fossil plant options.

- ensures equity and fairness in the sharing of the benefits and costs of electricity and in demand management programs.

- ensures Hydro has a lead role in the option selection process.

- continues consultation with the public as the study progresses to ensure that their needs and expectations are met.

9.3 Energy Use and Lifestyle

Ontario residents appear to place a high priority on a good life and upward mobility. Improvements in the quality of life and the goal of home ownership remain fundamental social values. A secure, reasonably- priced supply of electricity is seen as vital to Ontario's quality of life and economic well-being.

People expect to acquire more appliances or electrical products, particularly those providing comfort and convenience; to move to a larger home; and expect to increase the size of their family. An expectation that energy, particularly electricity consumption, will increase in the future is evident.

Electricity is seen as the energy source that has contributed most to Ontario's economic and industrial development over the years. Given public perceptions of its abundance and price stability, electricity is regarded as the energy source that will remain important in the future because it can provide the greatest security for Ontario's energy needs and well being, particularly in the areas of industrial and economic development. Most customers would not like to see economic growth constrained by the availability of electricity.

Ontario residents tend to feel secure about the province's energy outlook. They believe that there is little likelihood of any kind of energy shortage in the next five to ten years. Many are inclined to expect energy surpluses, electricity and natural gas being cited the most often. Ontario is seen as being extremely well-endowed with hydro electric or water power resources. This appears to be one of the reasons the public feels so secure about the future supply of electricity.

9.4 Need for Electricity

Most consumers say that they are now using more electricity than they did five years ago to meet their personal needs. In addition, they expect the

Province's electricity needs will increase in the next ten to fifteen years, given the desire for increased employment and economic development. Commercial and industrial customers particularly foresee growth in demand for electricity. A few participants do not agree, stating that as a principle, continuous industrial expansion and growth in electricity use are inappropriate.

Comments were made by participants on Hydro's forecasting abilities. Criticisms dealt with past performance, citing examples of over-estimating growth and the associated economic costs. Some participants were less critical and expressed their views on the uncertainties and difficulties associated with load forecasting. Many participants feel that if there are errors in load forecasting, they should be on the high side given the severe economic repercussions associated with shortages.

General opinion supports Hydro's forecast growth range of one per cent to four per cent. Most feel that Hydro should not plan for the high forecast, but base its planning on a middle range forecast. Participants think that this growth rate would avoid a risk of shortages and provide for a reliable supply with enough flexibility to respond to unforeseen increases or decreases in demand. Many participants feel that Hydro is building new facilities at about the right pace.

9.5 Customer Priorities

This section summarizes findings on the priorities most frequently expressed by program participants as important considerations in Hydro's planning.

9.5.1 Reliability of Supply

A reliable supply of electricity is identified as one of the most important priorities for Ontario Hydro by participants. Reliability is seen as a continuous supply of electricity with quick restoration of outages. The predominant view is that a reliable supply is essential to the competitiveness of Ontario industry and the needs of residential customers.

9.5.2 Reasonable Rates

Keeping rates reasonable ranks as an important priority in the opinion of most publics. Consumers expect that rates will increase in line with other energy sources, but faster than inflation. However, the expectation of a fair price for the product remains. A range of opinions on rates was also expressed including that electricity prices are currently too low; that they do not take into account all environmental and social costs; and that they encourage inefficient consumption. Most participants expressed a preference for reasonably priced electrical energy to ensure that industry remains competitive, and that individual customers can afford and enjoy the benefits of electrical applications.

9.5.3 Protect the Environment

The environmental effects of the production and transmission of electricity

are a high priority concern of all publics. Options that both minimize the environmental impacts and keep rates reasonable are preferred by participants. Many participants, however, expressed a willingness to pay more for electricity to protect the environment. Preferences for specific options are based to a significant degree on the public's perception of the associated environmental impacts. Hydraulic generation, alternative technologies such as solar, wind and energy from waste, and demand management initiatives are felt to have the least environmental problems. Concerns about air pollution from coal-fired plants, radioactive waste disposal and the impact of transmission lines suggest that options involving fossil and nuclear generation and significant transmission expansion are least preferred from an environmental standpoint.

9.5.4 Promote Wise and Efficient Use

Hydro is seen by most participants as having the responsibility for encouraging consumers to use electricity wisely and efficiently. Inefficient equipment and wasteful consumption habits were identified as prime targets for such efforts. Hydro is also seen as playing a key role in marketing electricity for applications that are efficient and economical for the customer.

9.5.5 Flexibility

Flexibility was an apparent theme in the results of the consultation program. Most participants are aware of, and accept the difficulties and uncertainties associated with the development of an electrical system. Many customers appear to want an electrical system that can respond to a range of possible load forecasts as well as the unexpected/unforeseen situations.

9.5.6 Diversity of Resources

Many participants suggested that Hydro should investigate a broad range of options which will use a diversity of resources. Support was evident for analyses of a variety of fuel sources and generating technologies -- conventional and alternate. Some felt that renewable energy sources, such as solar, wind, and biomass should be given priority in research and development. Most participants wanted a full investigation of the feasibility and risks of various forms of energy before any alternative is rejected.

9.5.7 Contribute to the Economy

There are a number of areas where participants feel that Hydro has had both beneficial and negative economic impacts. In general the public expects Hydro to continue to provide benefits while minimizing negative aspects. Maximizing the creation of jobs for Ontario is identified by participants as an important priority as it would contribute to the province's economic well-being. Some participants feel that Hydro should pursue options that contribute to regional development objectives. Others feel that job creation and regional development are government responsibilities or that support for

such initiatives results in a "boom bust cycle" of development.

9.5.8 Minimize Borrowings and Debt

A number of participants feel that Hydro should select options that minimize increases in borrowing and the debt load. A number of participants see Hydro's current debt as too high and as having negative economic implications. The debt is seen as placing limitations on the province's ability to finance other programs as well as placing an undue burden on individual customers. Hydro's financing practices do not appear to be well-understood by most participants.

9.5.9 Minimize Social and Land Use Impacts

Concerns about major transmission system expansion included comments about the negative social impacts on the affected landowners and adjacent communities. Agricultural representatives expressed concerns about impacts of transmission lines on farm activities, while others note the potential for conflicts among social objectives such as forest management, environmental protection, and preservation of agricultural land.

Large scale generation projects are seen to create some negative impacts on adjacent communities with the potential for "boom and bust" situations. Many publics perceive that the benefits associated with the influx of project workers is countered by the attendant strain on both the physical and social services of the affected municipality. Measures to avoid or reduce impacts through careful design, construction and operation of facilities are supported by many participants.

9.5.10 Public Health and Safety

The importance of public safety is underscored by the participants' preference for options that are seen to reduce the risks to public health and safety. For example, hydraulic generation is seen as much cleaner and safer than coal or nuclear power.

9.5.11 Equity and Fairness

The question of "who pays" and "who benefits" evoked a wide range of comments. There are definite differences of perception about what the real benefits and costs are, as well as about how the benefits and costs are shared, and how they should be distributed in the future. Some participants, especially from the agricultural community and northern Ontario, felt that they bear a disproportionate share of the negative impacts of facilities while paying a higher rate than consumers in the urban, industrialized areas in southern Ontario.

Almost all participants express support for the general principle that all electricity consumers should pay an equitable share of the costs. Concern was also expressed by many participants that demand management initiatives be fair to different types of customers, regions, and to participants and

non-participants in the programs. However, some of the comments by participants suggest some confusion about this basic principle. For example, program results show that there is some support for Hydro offering rate-based incentives to create jobs, stimulate the economy, and/or achieve conservation targets.

9.5.12 Voluntary vs. Mandatory Programs

In general, most participants express a preference for options that result in the least lifestyle changes for the individual. Most customers want the ability to make choices about their electricity use, rather than have mandatory changes in energy use imposed on them.

9.5.13 Energy Self Sufficiency

Many participants feel Hydro should continue to rely on indigenous energy sources to ensure a secure energy supply and to create and maintain jobs in the province. However, some suggest the need for an integrated federal policy with more interprovincial exchanges of energy and better co-ordination with other energy supplies such as natural gas.

9.5.14 Exports

Many publics feel that, if the electricity is excess to Ontario's needs, Hydro should continue to export electricity to the United States since export revenues help reduce rate increases for Ontario customers. Some participants are critical of exports believing that exports increase the need for new generation, that such sales are subsidized and do not reflect the real costs of production, and therefore have negative economic implications.

9.6 Ontario Hydro's Role

Hydro's role is widely seen as being more than that of a utility which produces electricity. The public sees Hydro as a company owned by the people of the province which is a marketer and supplier of electricity, a contributor to the provincial economy, and a competitor with other energy sources such as natural gas. In addition, Hydro is expected to perform its activities in an efficient, environmentally, and socially responsible manner. Hydro is seen by most participants as the party that should have the lead role in developing plans to meet the province's future electricity needs. There is, however, confusion about, and criticism of, Hydro's dual role in promoting both increased use and wise use of electricity.

The government is suggested as the authority that should review and change Hydro's mandate to accommodate public expectations and future circumstances. Suggestions for changes that Hydro might consider in its role as supplier of electricity and as an instrument of economic policy were made by participants. Suggestions related to demand management include: offering customers voluntary conservation initiatives; customer education with the emphasis on wise and efficient use; and appropriate incentives such as time-of-use rates, low-interest loans, etc. Changes to support Hydro's

economic development role included: renewed emphasis on "low cost power"; promotion of electrotechnologies; special incentives or discounts to industry on power rates or equipment; and long term guaranteed electricity supply contracts. Others, however, feel that Hydro is not sufficiently controlled and suggest that the government make Hydro more accountable.

9.7 Decision-Making Processes

General support and approval for the consultation activities to-date was expressed by participants. Continued public involvement in the planning process to meet future electricity needs is supported by almost all participants. They see this involvement as necessary to ensure that their needs and expectations are met. More specific comments were as follows.

Some groups suggested that the public should have been involved earlier in the process during the conceptual planning phase. A few organizations mentioned the need for financial assistance for their continued participation in consultation and legislated hearings and to hire independent experts to assist their involvement in studies of this type. These groups also suggested that more time be provided in the study process to allow groups to participate effectively and that participants should select the groups to be involved. However, some participants also expressed the opinion that too much time and money is now spent to involve the public in Hydro's decisions.

Some participants felt that Hydro provided too much information while others thought it too little. Additional information requested by various program participants included subjects such as provincial energy planning policies, and long range projections and studies, etc. Participants prefer that information be presented in a concise, comprehensive, and unbiased manner.

General support for a formal approvals process for Hydro's generation and transmission projects including a thorough examination of all of the alternatives is evident among the participants. However, many felt that the current approvals process for facilities and rates, etc. was too long, too complex, and too expensive. The southwestern Ontario transmission approval process was described by regional participants as "having no winners".

Many participants, including municipal utility representatives, felt that the approvals processes needed streamlining but there is no apparent consensus on how it should be changed. Suggestions made by participants were that Hydro be allowed powers to bank approvals in order to shorten facility planning lead times and that municipalities be allowed to hold plebiscites on major Hydro decisions affecting them.

The public recognized that no perfect solution is likely given the trade-offs required. Many criteria are suggested as being important when trade-offs are being made. As well as the use of common sense and the objectives implicit in Hydro's mandate, the other criteria are described in Section 9.5 - Customer Priorities. Few suggestions were made on how the trade-offs should be made, however. Many participants favoured elected officials, e.g. members of the provincial legislature, making the trade-off decisions.

9.8 Demand Options

- Widespread support is apparent for Ontario Hydro offering incentives to encourage customers to use electricity more efficiently or to shift their consumption to off peak periods. These incentives are supported as long as they are available to all customers, and are not seen as increasing rates, as punitive and/or as mandatory. Although, financial incentives might increase the public's acceptance of mandatory programs, voluntary participation is strongly preferred. Some participants expressed opposition to incentives on the grounds that they only delay the need for additional facilities, others felt the most significant, cost effective actions to save energy have already been taken by consumers, and many felt that more than moderate incentive levels could lead to inequitable cross-subsidizations.

- Ontario Hydro is seen as having a lead role in the development and implementation of demand management options. Municipal utilities expressed an interest in participating with Hydro in their development although the Municipal Electric Association's brief to the Select Committee identified some concerns with demand management. Public support is evident for Hydro and the municipal utilities working co-operatively to develop and implement demand programs. Approaches to demand management suggested by the participants include: customer education which received widespread support; promotion of energy efficient homes; timed water heaters; the development of municipal bylaws setting out energy efficiency standards; financial incentives including discounts, low interest loans and rebates for efficiency improvements and insulation; and efficiency standards for appliances.

- In considering demand options, many participants make a distinction between conservation in the sense of improving efficiency and in the sense of frugality or doing without. There is strong support for options which improve efficiency and less support for options which could mean doing without the benefits of electrical applications or result in negative changes to their lifestyle.

- Commercial/industrial customers appear to be less interested in incentives than residential customers. Many feel that they have less flexibility to take advantage of demand options but would be interested in efficiency improvements which improve their competitive position. Many commercial/industrial customers look to Hydro to provide advice and assistance in this area.

Conservation

- Incentives to encourage the wise and efficient use of electricity received general support. These initiatives are supported as long as customers feel they are not being required to forego the benefits of electricity use nor to subsidize others. The public has developed an energy conservation consciousness and made changes in its electricity consumption. These trends are expected to continue. The public favours

conservation initiatives as they are seen as supporting good stewardship of resources, are less costly and less damaging to the environment as well as being responsive to current energy use inefficiencies. Some participants point to the positive conservation program experience in the United States, Europe, and Japan. Some participants feel that increased electricity use will be associated with conservation efforts, as other fuel sources are replaced by electricity to achieve efficiency improvements.

Load shifting

- Rate-based and non-rate-based incentives to encourage load shifting by customers were suggested, but with qualifications. Attitudes towards time-of-use rates are positive so long as customers don't feel that peak rates are being set higher to cover discounted rates during off-peak hours. An appropriate incentive is perceived to be a rate discount in the range of 20-25 per cent of their monthly bill. Non-rate approaches suggested included load control devices on industrial equipment and residential appliances and digital metering equipment to help customers analyze their consumption and a change in daylight savings time.

9.9 Supply Options

- Hydraulic generation is the most preferred option as it is seen to be in abundant supply, to have the lowest cost, and be the least destructive to the environment. In addition, it is viewed as an indigenous energy source, contributing to job creation and revenues (water rentals) and having a longer life span than other supply options. Opposing views see hydraulic potential as being limited, having construction and operation practices damaging to the environment and as destroying the province's last 'wild' rivers. Many participants would like to see Hydro place a greater emphasis on small private and community sponsored hydraulic projects and improve the buy back rate for surplus electricity from private producers.

- Natural gas-fired generation appears to be a favoured option when cost is not considered. Its supporters see it as being clean, cheap, in abundant supply, having few environmental problems and low handling costs. Its critics see natural gas as being expensive, unsafe and better used directly as a heating fuel. Some participants suggested that natural gas and electricity requirements should be planned together.

- Alternate energy technologies enjoy general support as they are perceived to be less capital-intensive and less damaging to the environment. Of the alternate energy technologies, solar power appears to be most preferred and ranks highly when non-conventional and conventional options are considered. Solar power is seen as being low cost, clean and renewable. Wood burning generation is supported in northern Ontario. Burning municipal solid waste was supported by many participants, however, concerns were expressed about the emissions of such plants. While photovoltaics, wind generation, and other alternative technologies

are viewed positively the public expects that their higher costs will limit their use to situations where they are cost effective such as northern Ontario and remote communities. Pumped storage is not a well known nor understood option.

- Widespread support exists for co-generation. It is seen as a desirable way of making greater, more efficient uses of existing resources, creating jobs and competition for Hydro. Improvements in the buy back rate for privately-produced surplus electricity and a buy back rate based on Hydro's avoided costs were recommendations made by participants.

- Nuclear power stations appear to be preferred by the public over coal-fired plants and purchases but rank behind hydraulic, alternate energy technologies and natural gas options. From a cost standpoint, nuclear power is preferred to natural gas generation. Supporters see nuclear energy as being cheap, safe, cost effective, dependable and proven. In addition, it is seen as a job creator and contributor to high technology expertise. Supporters also see it as reducing acid rain and see radioactive waste disposal as manageable. Opponents express concerns about the risks of nuclear energy and its fuel cycle to public health and safety and the environment, as the major issues. In addition, many participants expressed concerns about the high capital costs of nuclear plants and the associated impact of debt, the long-run costs of waste disposal and decommissioning as well as the relationship between nuclear technology and weapons proliferation.

- Purchases of power from Manitoba and Quebec received mixed comments. Some participants support purchases if there is a clear cost advantage and hydraulic generation is used. However, there is an apparent reluctance to see Ontario become too dependent on other provinces because of the loss of security of supply, the potential loss of jobs and transmission line requirements.

- Coal and oil fired generation appear to be among the least favoured options. Both are seen to create air pollution and environmental damage. In addition both energy sources are seen to be expensive and non-renewable. Acceptance of both types of fossil generation increases if these new plants are fitted with scrubbers or use new, clean technology -- but not to the point of widespread support.

9.10 Government Consultation and the Select Committee on Energy

Government consultation activities included briefings of provincial and federal government ministries, government sponsored conferences, reviews of government publications and testimony before the Select Committee. These activities provided opportunities for Hydro to discuss and consider ideas and emerging policy directions on planning for future electricity requirements with the government.

Hydro participated in two conferences on energy sponsored by the province -- Energy 2000 and Small Hydro. The Energy 2000 conference, held in late 1985,

was a major international energy symposium which focused on the importance of energy issues, supply options and trends and policies in Ontario's future. Two detailed papers by the Ministry of Energy -- The Shape of Ontario's Energy Demand and Fuelling Ontario's Future were reviewed by Hydro. In March, 1986 the Small Hydro conference examined the progress by Ontario's small hydro industry during the last five years.

Hydro staff have also reviewed a series of provincial and federal government publications on electricity as part of the research and analysis activities of the demand/supply study. These publications include: Parallel Generation in Ontario, New Directions for Meeting Tomorrow's Electricity Needs, Streams of Power and the memorandum of understanding between the federal and provincial governments on conservation.

The deliberations of the Select Committee on Energy culminated in 26 recommendations to the provincial legislature on Ontario Hydro affairs. During the Committee hearings Hydro requested direction from the Committee on five specific topics (see Figure 9-2). The answers to these questions are addressed and cross-referenced by the Select Committee with the 26 recommendations in its final report.

Figure 9.2

QUESTIONS RAISED BY ONTARIO HYDRO

Demand Options

1. Should Ontario Hydro influence demand? If so, how? - conservation only? strategic growth only? or both?

2. What criteria should be used to evaluate conservation programs?

3. Should conservation potential be limited by the "no losers" screening test?

Supply Options

4. Should priority be given to certain supply options? - hydraulic? purchases? parallel generation? alternative technologies?

5. How can approval times be reduced?

- Should Ontario Hydro influence demand? If so, how? Conservation? Promotion? Or both?

Demand side options - load shifting, strategic load growth and conservation have an important role to play in a balanced electricity system. The Committee has recommended Hydro develop a comprehensive conservation strategy (Recommendation 9) and take steps to develop a stronger capability for acquiring conservation resources (Recommendation 10). The Ministry of Energy (Recommendation 19) and the Ontario Energy Board (Recommendation 18) are

recommended by the Committee as the bodies that should review and evaluate Hydro's strategic marketing and resource plans to ensure a balanced system. The Ministry of Energy was asked (Recommendation 11) to investigate the feasibility and desirability of developing labelling programs and efficiency standards for appliances and for the construction of more efficient buildings via incentives and/or changes to the building code.

- What criteria should be used to evaluate conservation programs?

The Committee has recommended that Hydro develop a mix of resource options based on criteria of cost, flexibility and reliability. The use of planning and forecasting methodologies based on adequate end use data is recommended to ensure that demand options are treated equally in the planning process (Recommendations 5 and 6).

- Should conservation potential be limited by the "no losers" screening test?

The Committee did not ever believe Hydro should use the "no losers" test. In its place, Hydro should develop comprehensive strategies directed at distributing the benefits of conservation to all customer groups (Recommendation 9).

- Should priority be given to certain supply options?

The Committee recommends that Hydro pursue cost-effective options that are flexible and help diversify our resource mix e.g. accessible, cost effective hydraulic sites and parallel generation (co-generation, small hydro and municipal solid waste) in accordance with Ministry of Energy parameters (Recommendations 13 and 14). The major firm purchase agreement option should not be pursued at present, however the pursuit of improved interconnections with Quebec will keep the option open for review in the mid-1990's (Recommendation 15).

- How can approval times be reduced?

To improve the approval process, the Committee recommends that Hydro expand its planning process to include industry allies and informed public groups (Recommendations 23 and 25) and expose the resource plan to a public review (Recommendations 17 to 20).

The provincial government has acted upon two of the Committee's recommendations that Darlington NGS should proceed and that an independent review of the safety of the design, operating procedures and emergency plans associated with Hydro's CANDU nuclear plants should be undertaken.

The balance of the Committee's recommendations are currently being considered by the provincial government.

10.0 ANALYSIS OF REPRESENTATIVE PLANS

There are many options available for supplying electricity and many options available for saving it. Chapter 8 of this report discusses the cost and technical aspects of these individual options. The individual options can be combined in various ways and consequently a wide range of choice is available for meeting electricity needs. This chapter provides some examples of ways in which the people of Ontario could meet their electricity needs.

By choosing the different options and mixes of options the people of Ontario will experience different rates, different incentives to reduce demand, and different construction programs to provide supply. These will result in different impacts on the society and environment of Ontario. Accordingly, as many choices as possible are illustrated to show people examples of the range of choice available to meet future electricity needs.

Generally speaking, there are four broad approaches or families of strategies that can be used to group and describe the various ways to meeting electricity needs, outlined by Figure 10.1. It should be noted that the strategies and plans discussed and used here illustrate certain resource choices. However, they are not as fully developed as the draft demand/supply planning strategy.

The four broad approaches are:

1. Strategies that rely primarily on managing demand through options such as:

   - incentives for load shifting;
   - incentives for more efficient use of electricity; and
   - raising rates to limit the growth in electricity use.

2. Strategies that rely primarily on providing new electricity supply through options such as:

   - independent and alternate generation;
   - hydraulic generation;
   - fossil generation;
   - nuclear generation; and
   - electricity purchases.

3. Mixed strategies in which demand and supply options are combined.

4. Strategies in which smaller generating resources and demand options are distributed around the province.

Within these strategy families, representative plans are developed which mixed varying amounts of the available options. All the plans have some further hydroelectric development and additional independent generation.

Plans are developed that contained different levels of incentives for demand management. These incentives are assumed to be capital payments made by Hydro towards the cost of the demand option. Incentives to customers of fifty and one hundred percent of the capital cost of the demand options are illustrated. Low cost demand management is a limited resource. When fully utilized, an all demand plan could rely on raising electricity prices to control demand. Alternatively, the balance could be met by generation added towards the end of the planning period when economic demand options are not sufficient. The example illustrated shows nuclear generation. All supply plans are illustrated with different mixes of nuclear, fossil and purchases. Mixed plans with moderate incentives for demand management are developed with a variety of supply sources and different timings of approval processes. Plans which use demand management and smaller generating units distributed around the province in order to reduce or defer the amount of long distance transmission lines required and to more equitably distribute any economic benefits and environmental impacts are also developed.

In all about 15 representative plans have been developed. These are listed in Figure 10.1. The resource requirements of these plans are estimated as well as impacts of these plans on costs, reliability, the environment, the provincial economy and on human resources. The way in which plans could adapt to changing circumstances is also addressed. The various circumstances tested are:

- more or less demand for electricity service than expected,
- more or less success in achieving demand management,
- more or less success in obtaining approvals for new supply options,

and combinations of the above.

The options appropriate to each particular plan are chosen in order of increasing standard cost, and in amounts necessary to meet the demand. However, the demand is modified to reflect the effect of changes in the price for electricity under that plan.

Further details of the strategies, the representative plans and the impact assessments can be found in the supplementary report "The Analysis of Representative Plans". In all, 115 combinations of plans and circumstances, have been tested and are presented for consideration.

The analysis of representative plans used data from the December 1985 load forecast but the results would not change significantly if the December 1986 forecast was used. For example, under the most likely conditions, the cumulative total demand/supply resources needed by 2010 was 8000 MW with the December 1985 forecast, the same as it is estimated to be with the December 1986 forecast.

It is not the purpose of this chapter to give a detailed description of these representative plans. Nor is it intended to identify preferences. Rather, this chapter reports conclusions drawn from the analysis of the representative plans as a basis for further discussion of what a preferred strategy might be.

FIGURE 10.1

ALTERNATIVE DEVELOPMENT STRATEGIES

BROAD STRATEGY FAMILY	REPRESENTATIVE PLANS[1]
DEMAND	
	PRICE
	INCENTIVE (HIGH) & PRICE (BALANCE)
	INCENTIVE (HIGH) & NUCLEAR (BALANCE)[4]
ALL SUPPLY	
	NUCLEAR
	PURCHASE & FOSSIL
	FOSSIL
MIXED[2]	
DEMAND MANAGEMENT &	NUCLEAR[3]
DEMAND MANAGEMENT &	PURCHASE & FOSSIL
DEMAND MANAGEMENT &	FOSSIL
DEMAND MANAGEMENT &	NUCLEAR - DELAYED BY PURCHASE
DISTRIBUTED RESOURCES	
	INCENTIVES (HIGH) & FOSSIL
	INCENTIVES (MODERATE) & FOSSIL

1) Variations to all plans are considered covering combinations of higher, most likely and lower load growth; better than expected, expected, or less than expected customer acceptance of demand management programs; and alternative outcomes of the approval process for the first new nuclear station.

2) All mixed plans have moderate incentives for demand management.

3) Variations to this plan are considered with different timings for the start of approved processes, with and without fully developed fossil-fuelled alternatives. This illustrates the effects of approval processes on flexibility.

4) The major focus in this plan is on demand management. When demand management is insufficient towards the end of the study period, the balance is met with nuclear generation.

10.1 GENERAL CONCLUSIONS

> Electricity needs can be met by any of the representative plans under the range of circumstances considered if we start planning now.

Electricity needs are hardest to meet if load grows faster than expected. The key to meeting the higher growth rates economically and reliably is to start the planning (not the implementation) of the required demand or supply options now.

The result of the long lead time required to achieve large amounts of demand management or to construct new supply requires that we start planning now. Demand programs take considerable time to implement. It has been assumed that there will be a period of research, development and demonstration until 1990, after which implementation will follow. Market saturation would take ten years beyond 1990. Lead times for supply options, under the current process, are estimated to be around five years for planning and approval and three to eight years for construction, depending on technology.

If we plan now for the upper load growth and if higher than forecast needs develop, the plans can be implemented. If needs develop as forecast, the start of construction programs can be delayed for a few years. Plans can be put on hold until required if growth is less than forecast.

If planning on supply options is delayed until around 1992 meeting the upper load will be difficult. Reliability will deteriorate through the 1990s, and short lead time options, such as combustion turbines (burning gas) or emergency purchases, which are generally more expensive, will have to be used in significant quantities.

> All plans have environmental impacts that require careful management. Different plans have different impacts.

All plans can be designed to meet existing environmental regulations while meeting lower and forecast electricity needs. The costs of doing so are included in the analysis of the plans. Plans relying heavily on fossil generation may not be able to meet existing acid gas limits while meeting higher than forecast electricity needs.

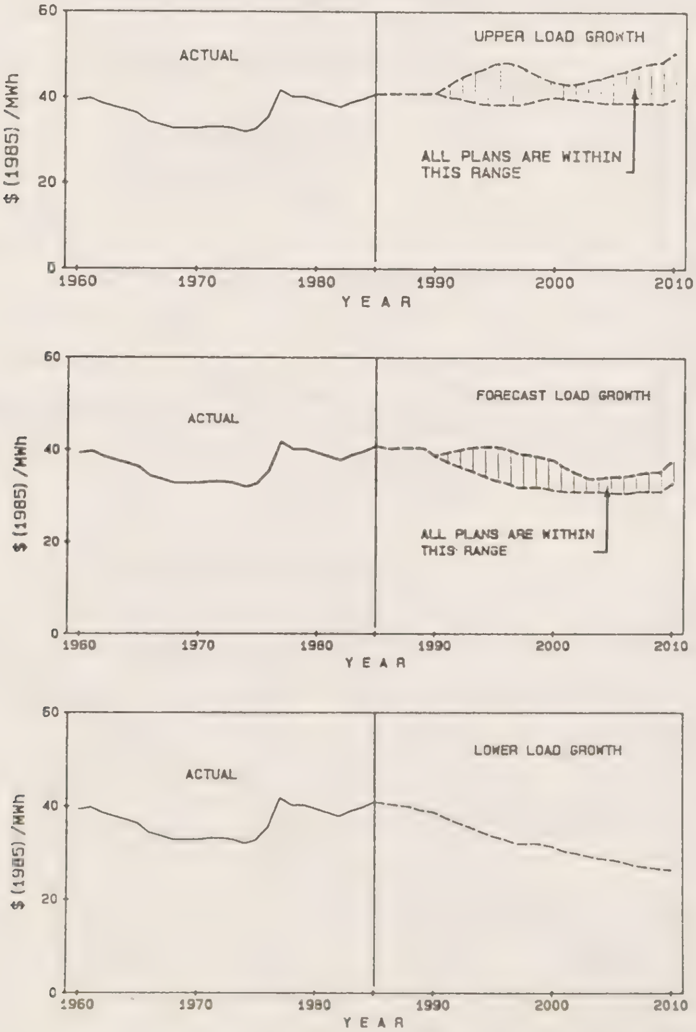
> The greatest benefits to the provincial economy come from plans that rely on demand options or that generate electricity from indigenous fuels.

Analysis of the representative plans confirms the analysis of the individual options. The demand management programs have high Ontario content and are chosen to be cost effective.

Electricity rates among the different plans and load growth scenarios vary as much as +20% to -40% from today's rates.

This is illustrated in Figure 10.2. The different graphs show the electricity rates for the three load growth scenarios. In all cases, the effects of inflation have been removed and electricity rates are expressed in 1985 dollars per MW.h. For the upper and most likely projections, the different plans produce different rate levels which are shown as a range. Electricity prices are lower with lower load growth as less new major investments are required. The upper side of the range results from the rate "bulge" during the 1990s being characteristic of high incentive demand management plans and the subsequent rising trend being characteristic of fossil-based plans. The lower side of the range is characteristic of mixed plans and the use of new nuclear generation stations. It should be noted that the apparent magnitude of the variation in rate outlooks is somewhat masked by the fact that a large proportion of costs which affect rates are common to all plans (ie, the power system currently in place or committed).

FIGURE 10.2
AVERAGE CUSTOMER COST OF ELECTRICITY



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10.2 DEMAND MANAGEMENT CONCLUSIONS

> Demand management can make an effective contribution to meeting electricity needs, but could only meet all the growth in demand if load growth is less than forecast.

It is estimated in Chapter 8 that 1000 - 4000 MW of demand management could be available by the year 2000 under the most likely load forecast. If incentives equal to 100% of the cost of the demand options are provided the amount achieved would be towards the upper end of this range. The assumed potentials with different incentive payments are shown in Figure 10.3, together with the requirement for further dependable demand/supply resources. When the requirement exceeds the contribution from demand management, additional major supply is needed.

FIGURE 10.3
POSSIBLE CONTRIBUTION OF
DEMAND MANAGEMENT

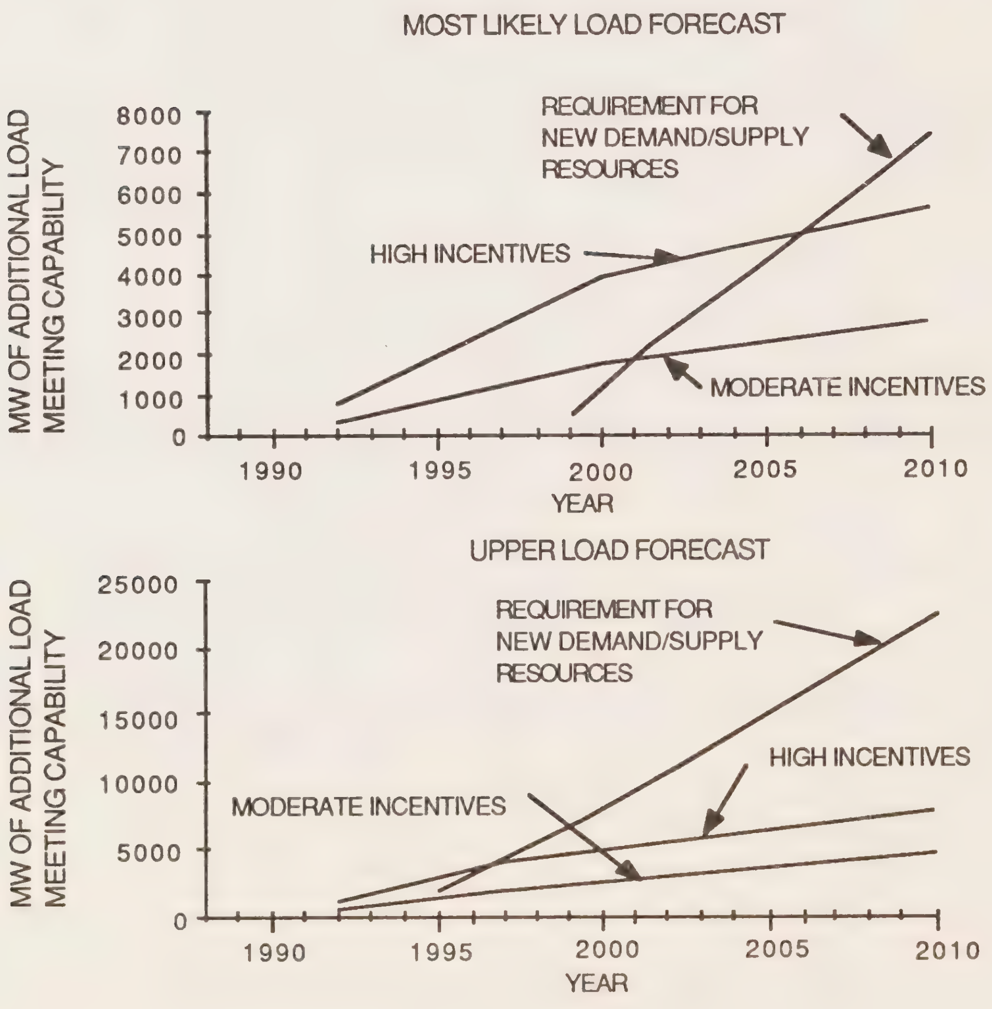


Figure 10.4 shows in more detail, the dates by which additional major supply resources are needed, under a range of possible contributions from demand management.

FIGURE 10.4

NEED DATES FOR ADDITIONAL MAJOR SUPPLY RESOURCES

	LOAD GROWTH				
	LOWER	MOST LIKELY (1)(2)		UPPER (1)(3)	
		INCENTIVES		INCENTIVES	
		50%	100%	50%	100%
CONTRIBUTION OF DEMAND MANAGEMENT					
LOW SUCCESS	After 2010	2000	2004	1995	1997
MEDIUM SUCCESS	"	2002	2007	1997	2000
HIGH SUCCESS	"	2004	2007	1998	2001

(1) Assumes independent generation & hydraulic programs in place.
(2) Hearn & Keith retired (1990), Lakeview retired 2007.
(3) Hearn, Keith and Lakeview rehabilitated.

If Ontario Hydro paid all the cost of economic energy efficiency improvement measures, the most likely load growth can be met to 2007 without adding new generation. This assumes that existing plant can be renovated, and the contribution from demand management programs is as expected and the necessary transmission is installed. However there is uncertainty as to the degree of public acceptance of demand management. If Hydro fails to capture the expected amount, either more expensive energy efficiency improvements would have to be funded, higher prices would have to be used to reduce demand, or major supply facilities would be required.

To meet the higher ranges of electricity needs that might develop, both demand management and supply options would be required. Figure 10.3 shows that at higher growth rates an additional 8600 MW of load over and above the capability of the existing and committed system has to be met by the year 2000. Only 5000 MW of demand management are estimated to be available even with 100% incentives, so about an additional 4500 MW (3600 MW + 24% reserve) of supply options would also be needed.

> Early implementation and acceptance of demand management is required to achieve a significant delay in the need for additional supply facilities.

If load growth is as expected, moderate demand management programs need to start contributing to the system by around 1990 to allow maximum delay of new supply facilities.

However, demand management programs need to be started as soon as possible if they are to have the maximum impact in delaying the need for supply facilities in the upper load growth scenario. An early start also allows efficiency improvements to new buildings and equipment to be made earlier, minimizing the need to retrofit later at higher cost.

The amount of demand management that can be achieved at any particular level of incentives is uncertain. Reducing this uncertainty could defer the need to start planning for supply facilities. Early market research and implementation of demand management may help resolve this uncertainty, as well as provide an infrastructure and human resource base for increased efforts if needed.

> Plans with high incentives for demand management tend to have higher electricity rates than plans with more moderate levels of incentives.

Figure 10.5 shows typical rates for plans with high incentive programs compared to the range of rates for mixed plans with the most likely load growth. Rates are higher, particularly in the 1990's. With upper growth, unit electricity costs are also higher with higher incentives than with moderate incentives through the 1990s. Even though rates are higher, total electricity service costs of participating customers over the useful life of the demand options are not higher because of the lower use resulting from the efficiency improvements.

> Higher incentives or accelerated demand management programs may be economic in the upper load growth scenario. Lower incentives or delayed programs would be economic under the expected load growth.

Fossil fuel is expensive. Its use is higher in the upper load growth case and new fossil generation is required. Thus the benefits of demand management are greater than in the most likely load growth case and more demand programs would be economic. If loads are lower or as forecast, the need is further in the future and the focus would be on options which have a long life, and on those which, if not taken at the time, would be expensive to retrofit. For example, building energy efficiency into a new home, is less costly than retrofitting it with insulation later.

High incentive demand management programs have positive provincial impacts.

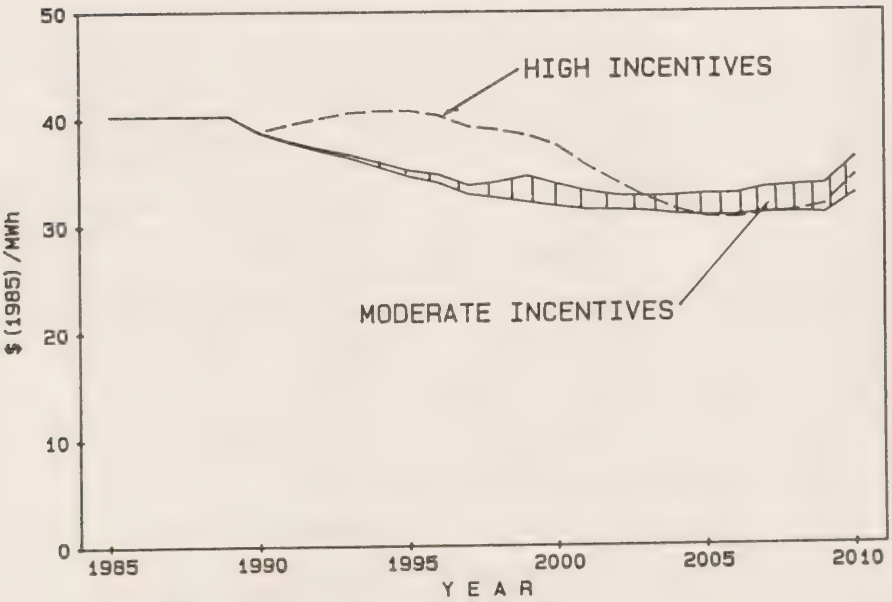
Plans with high incentive demand management have the best impact on the provincial economy. This is because the programs are cost effective, have high Ontario content and they free up customers' income for other use. This may encourage governments to become further involved in funding energy and specifically, electricity efficiency programs.

Increases in the price of electricity solely to reduce demand have negative impacts on the provincial economy.

The prices required are higher than the costs of alternative demand/supply plans and thus they are a drag on the economy, even if the excess revenues are returned to the economy.

FIGURE 10.5

AVERAGE CUSTOMER COST OF ELECTRICITY



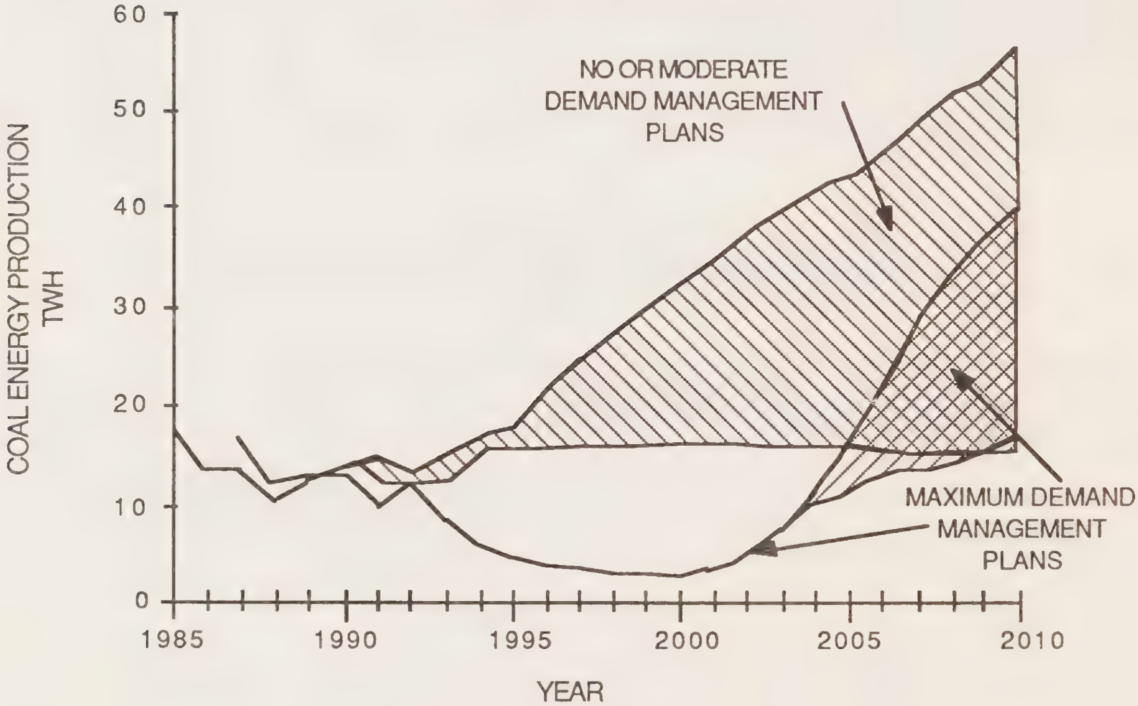
Most Likely Load Forecast

High incentive demand management programs can significantly delay the need for acid gas emission controls on existing coal fired stations.

Figure 10.6 shows the ranges of coal use under the most likely load growth with and without high incentive demand management programs. Plans with maximum demand management have significantly lower coal use through the 1990's. For these plans, the level of coal use after 2000 depends on whether nuclear or fossil plant is chosen to supplement the demand management when the retrofit opportunities are largely implemented. For other plans with no demand management or only moderate incentives, there is a range of coal use which depends on what other options are implemented.

FIGURE 10.6

EFFECT OF MAXIMUM DEMAND MANAGEMENT PROGRAM ON ELECTRICITY PRODUCTION FROM COAL



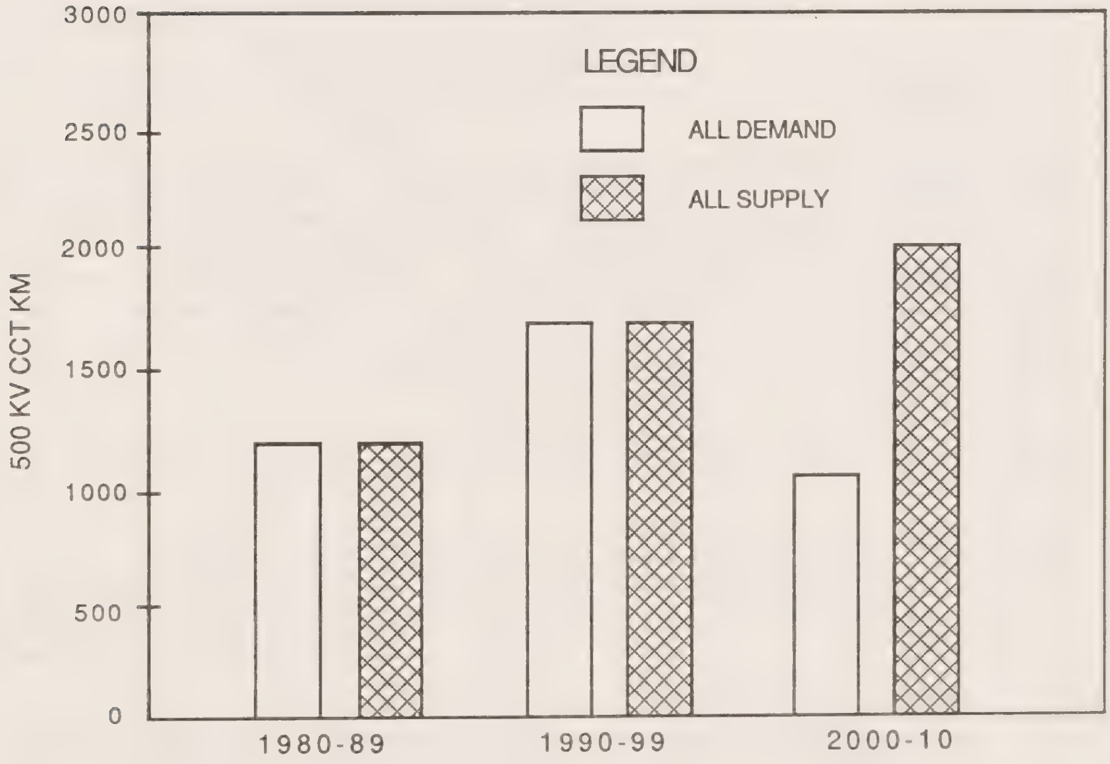
NOTE: Most Likely Load Forecast
Expected level of contribution from Demand Management programs

Demand management can reduce or defer the requirements for long distance transmission facilities.

Assuming demand management opportunities occur widely, they will reduce or defer the need for long distance transmission. However, there are substantial requirements in all plans for transmission before 2000. Even with maximum demand management further long distance transmission is needed after 2000 unless new generation is sited to reduce those requirements. Figure 10.7 shows the range of new long distance transmission required.

FIGURE 10.7

IMPACT OF DEMAND MANAGEMENT ON NEW LONG DISTANCE TRANSMISSION REQUIREMENTS



NOTE: Most Likely Forecast

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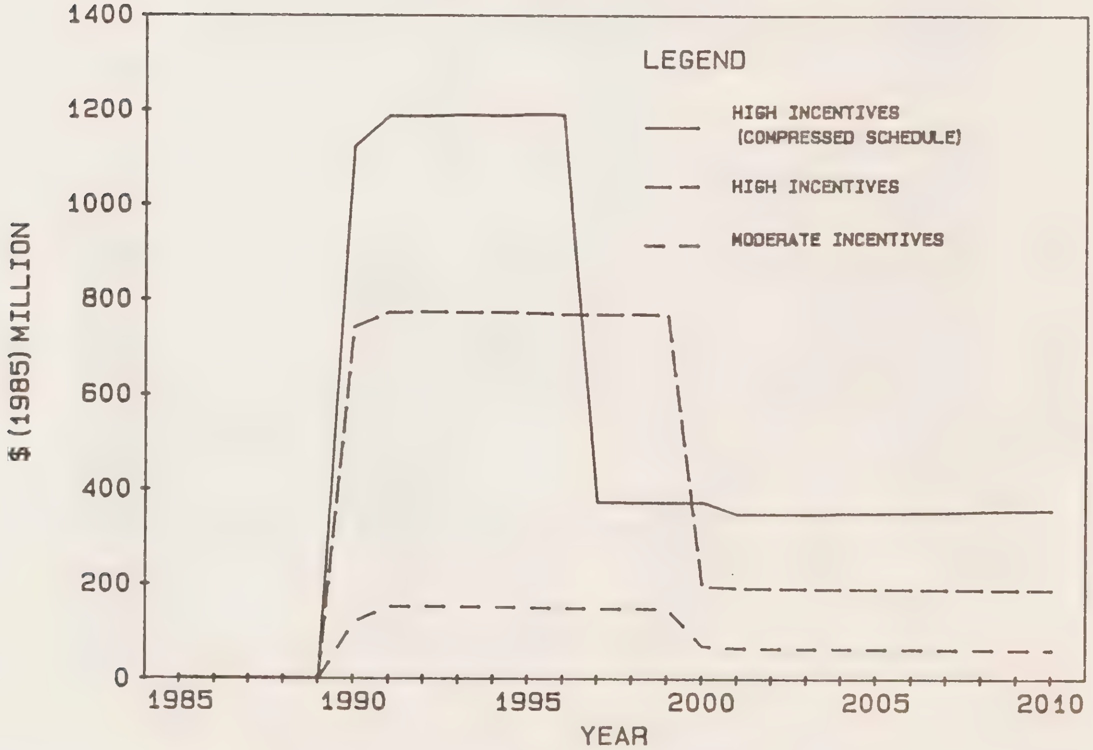
High incentive demand management programs would require a build up in capital expenditures and in human resources that will require careful management.

Figure 10.8 shows the demand management capital expenditures that would be required if moderate incentive and high incentive programs were implemented. Also shown are the expenditures if the high incentive program are accelerated and took 7 years instead of 15. The build up of expenditures, even allowing for simplifying assumptions, is marked. Building up organizational units among municipalities and contractors and the associated trade infrastructure takes time. This is similar to the problem of building up infrastructure for major supply programs if no major program is underway.

FIGURE 10.8

ANNUAL CAPITAL EXPENDITURE ON DEMAND MANAGEMENT



NOTE : Excludes demonstration programs

10.3 INDEPENDENT GENERATION CONCLUSIONS

> The amounts of independent generation available do not have a large impact on the requirements for other demand/supply resources.

As noted in the Supplementary Document, The Options, economic alternative technologies or additional independent generation could contribute 220-1350 MW by the year 2000. It accommodates up to two years load growth at the most likely rate, and compares with a requirement of about 8000 MW of dependable power by the year 2000 to meet the upper load growth.

The amount of independent generation, based largely on industrial cogeneration, in southern Ontario has little impact on the requirements for new resources. However, independent generation could have an appreciable impact in northern Ontario because of the significant potential in the pulp and paper industry. While independent generation is less subject to control by Ontario Hydro, it does have the advantage of providing diversity, for example, increasing the variety of generating resources and number of suppliers.

10.4 GENERAL CONCLUSIONS ON SUPPLY

> The size of the Ontario Hydro system is such that unit sizes of 500-800 MW are appropriate.

The Ontario Hydro system will consist of more than 30,000 MW of generation. Economical unit sizes of 500-800 MW represent only 2 to 3% of system size, and therefore, are relatively small increments. In addition, the annual load growth in the 2000s, to be met by supply and demand measures, is expected to be about 750 MW/year. Demand management programs might reduce this to around 600 MW/year. Supply facilities have considerable economies of scale. Units in the size range 500-1000 MW are significantly cheaper than smaller units. Thus unit sizes of this order are suitable.

> Planning now for major supply facilities is required to give confidence in meeting the range of demand that could occur.

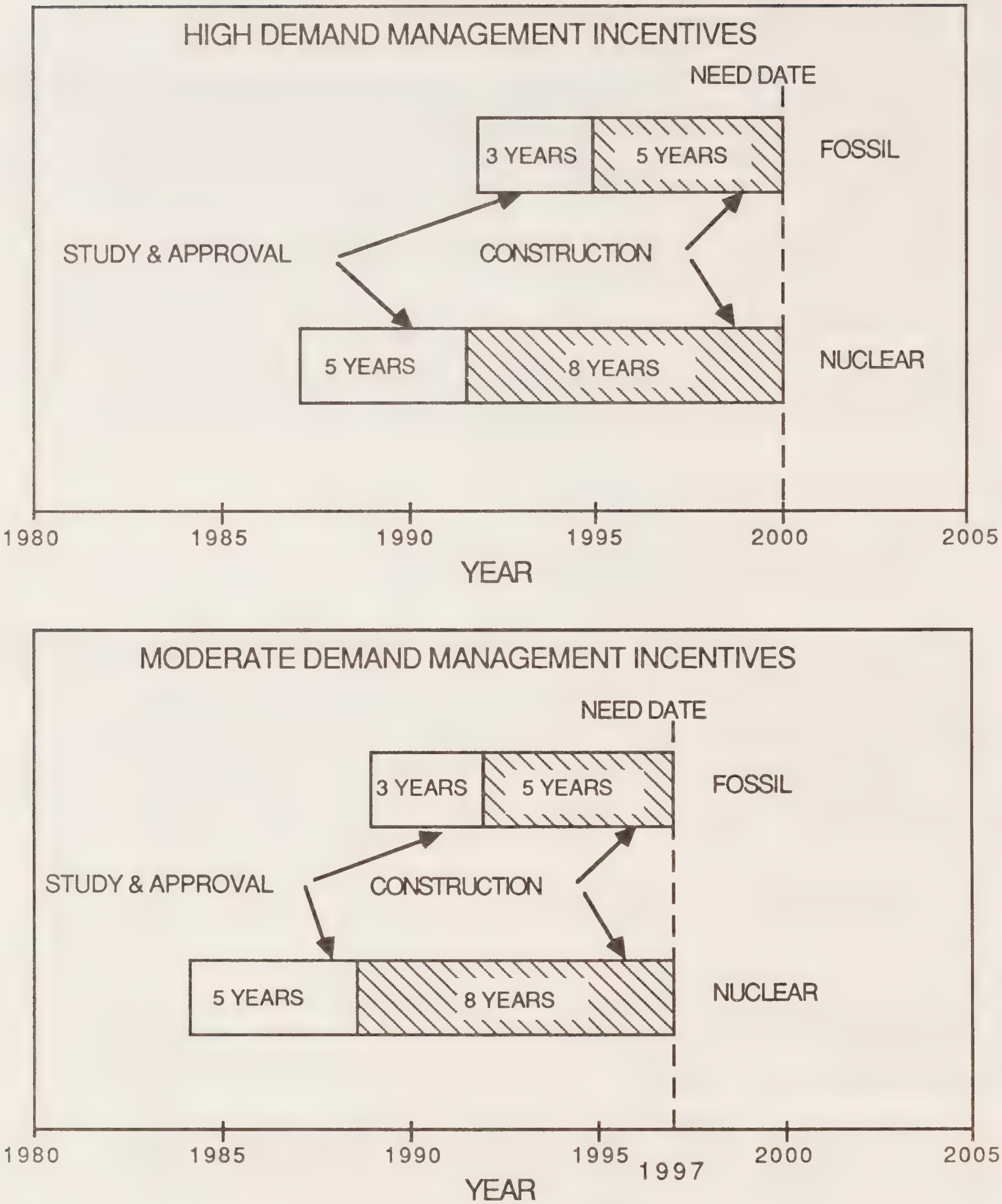
Figure 10.9 shows the scheduling of activities for major supply facilities that are required to meet the upper load growth assuming an economic hydraulic program, high or moderate incentive demand management and independent generation programs.

> Timely completion of planning and approval phases to meet the upper forecast would allow economical supply if load is as forecast or lower.

All plans show the need to start planning new supply facilities as soon as possible if the upper load growth is to be met reliably and economically, given current estimates of the time to obtain approval for, and to construct, new facilities. Delaying decisions would make meeting the upper load growth more costly ($6000 million). A study, which looked at a wider range of load forecasts than used in this scenario analysis, concluded that the optimal level of planning activities would be able to meet a load growth 1.5% per year above the probable load growth, should it occur. This

FIGURE 10.9

TIMING OF ACTIVITY TO MEET
UPPER LOAD GROWTH



Note: Assumes no site acquisition required.
Need date is that for major supply facilities taking into account additional hydraulic and independent generation,and high or moderate incentives for demand management.

approximates the upper load growth scenario that has been used in the analysis of the representative plans. The study assumed that the approval would be shelved and construction deferred if high growth does not materialize. Completing planning in anticipation of a higher load growth is inexpensive insurance since planning costs are much less than construction costs. However, while excessively early commitment can lead to underutilized economic generation with unacceptable rate impacts, moderately early commitment of economic hydraulic generation or nuclear need not carry a cost penalty, or have a large impact on rates because it would displace more expensive coal.

Another source of inflexibility due to approval processes is illustrated in a scenario where approval for one alternative is sought, but eventually denied after a delay of several years. At that time, it may be too late to seek approval for another alternative. The analysis of representative plans considered the benefits of seeking approval of nuclear and fossil alternatives together when major base load energy supply is required. This allows a rapid switch to the second alternative in case approval for the preferred alternative is denied. This approach gives increased flexibility under most likely load growth conditions and provides substantial cost savings if the load growth is higher than forecast, and both alternatives are required.

> Geographic distribution of resources can significantly affect the requirement for major transmission.

Ontario Hydro currently owns few sites suitable for further major thermal stations, and these are mainly east of Toronto on Lake Ontario. Use of these sites could lead to a locational mismatch between load and generation and have major transmission requirements. Use of a few new sites in other parts of the province could reduce the need for major long distance transmission.

To further reduce or defer the construction of new long distance transmission after the year 2000 could require many smaller fossil plants throughout the province. This would involve higher costs and higher collective environmental impact of the sites and the infrastructure to fuel these plants. Flexibility to meet lower than expected load growth may be improved, due to smaller scale and shorter construction times.

Meeting the larger requirements of the industrial areas of southern Ontario would require a mixed plan using distributed resources, including demand management, the most uniformly distributed resource, and large scale fossil or nuclear plants. Distributed generation, using technology that matches local requirements could be used to reduce transmission requirements and could provide regional development and employment benefits in regions where the facilities are located. Problems with this strategy would be to gain acceptance for the local generation and the associated transmission in each area. There could also be problems transporting coal to the distributed stations.

10.5 EXISTING PLANT

> Rehabilitation of existing fossil plant can reduce the need for new fossil plant.

Lennox GS (2200 MW) has been assumed to be brought back in-service in all the representative plans. Lakeview's life extension from 1997 to 2007 has been assumed in all plans. New nuclear or fossil plant could be built in time to replace Lakeview in 2007, if it were economic to do so.

In the upper load growth scenario Ontario Hydro has to build fossil plant in all the representative plans (except where price is used to choke off demand). The older Hearn & Keith generating stations comprise some 1400 MW, and could reduce this need for new fossil plant. However they would require lengthy and expensive rehabilitation and restaffing.

10.6 HYDRAULIC

> Hydraulic resources can make a useful but limited contribution. They can be useful in the supply of certain areas such as the Northwestern Region or to provide supply diversity and operational flexibility.

The amount of economic hydraulic resources is limited and the transmission required to incorporate the available sites is significant. Few sites are economic compared to nuclear due to the low energy capability of most remaining undeveloped sites. However, some 1500 MW is comparable in cost to fossil plant and offers the benefit of supply diversity and operational flexibility in the form of peak load following capability. Hydraulic plants can also provide an economic supply solution for certain load areas such as the Northwestern Region where it is not practicable to install large units due to system limitations.

10.7 NUCLEAR

> Nuclear plants are expected to reduce long run costs. Plans that rely on nuclear plant when major energy supply is required have lower costs.

Plans using new nuclear plant, instead of coal fired plant as the major energy producer, save some $5000-6000 million dollars (present value) if the most likely load growth comes about; and up to $10000 million in the upper load growth case. These figures could vary, either up or down, because of uncertainties about the costs of nuclear energy production, including waste disposal and decommissioning, and uncertainties about the costs of coal-fuelled energy production. However, reasonable variations are unlikely to eliminate the cost advantage of nuclear.

The analysis shows that advancing nuclear can reduce the long term costs of electricity supply and have positive impacts on the provincial economy. The benefits must be weighed against the risks of early commitment with uncertain growth.

There is improvement in flexibility to meet upper load growth with plans that rely on nuclear to meet the most probable base load energy requirements after allowing for the effects of economic demand management, independent generation and new hydraulic generation. As discussed in the next section, if new fossil-fuelled plant is relied upon to meet the most likely load growth, the acid gas emission regulations will restrict flexibility to use additional fossil-fuelled plant to meet upper growth.

A basic assumption of the representative plans is that sufficient capability is retained so that the nuclear option remains an available option after long gaps in nuclear construction. There is some concern that this capability may not be available. In addition, it will be necessary to continue to work with regulatory bodies including the Atomic Energy Control Board, to ensure that all phases of the nuclear life cycle, including decommissioning and used fuel disposal, are conducted in a safe and environmentally acceptable way.

10.8 FOSSIL

> Fossil plants for major energy supply have higher costs and potential difficulties with existing environmental regulations.

Figure 10.10 shows the range of coal burns after 2000, from existing and new stations, under the most likely load growth, for plans with and without nuclear. These should be manageable, with large numbers of scrubbers and using the best available technology. However, coal burns are significantly higher in the upper load growth and may not be manageable.

> Fossil plant will probably be needed to meet the upper load growth.

Lead time and siting considerations are such that shorter lead time resources, such as fossil plant, will likely be needed to meet the upper load growth. Figure 10.9 shows when planning activities need to be started for a plan with high incentive demand management program to meet the upper load growth. The figure assumes the expected demand management contribution, the rehabilitation of Hearn and Keith generating stations, and the implementation of a program of construction of new hydraulic stations. The figure shows that with currently expected lead times, if the decision to start the planning and approval work for a nuclear station is delayed past 1987, then there is a need for shorter lead time resources. Figure 10.9 also shows the requirements for shorter lead time resources, such as fossil generation, is substantially higher if a moderate incentive level program is followed.

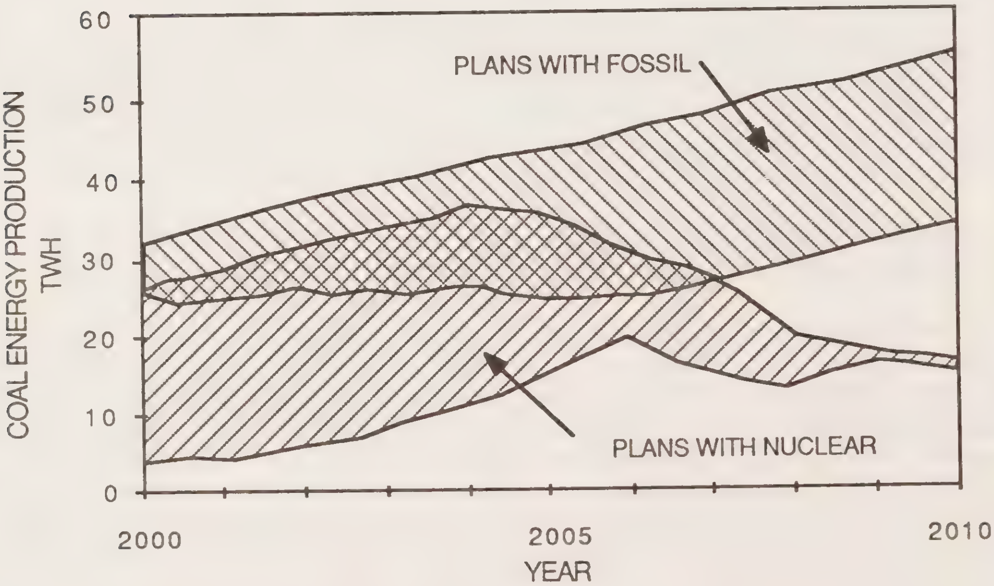
10.9 PURCHASES

> Purchases priced comparable to the lowest cost supply options can contribute to low electricity rates and diversity of supply. Purchases have less benefit to the provincial economy than demand management and supply options that use Ontario based resources.

The study of the representative plans support the intuitive conclusion that low cost purchases can be economic, but rigidity in timing and commitment should be avoided. It is likely that purchase options will reduce Ontario Hydro's borrowing requirements during the period of construction, although the costs of debt service would be included in purchase prices. Purchase options will tend to transfer construction out of the Province, reducing the level of economic activity in Ontario versus other plans, although some of the manufacturing of equipment may take place in Ontario. The lack of direct activity in the province associated with the purchase could be offset to some degree by favourable impact on rates and borrowing activity. However, the net impact is likely to be less than using other indigenous sources.

FIGURE 10.10

LONG TERM COAL BURNS



NOTE: Most Likely Forecast

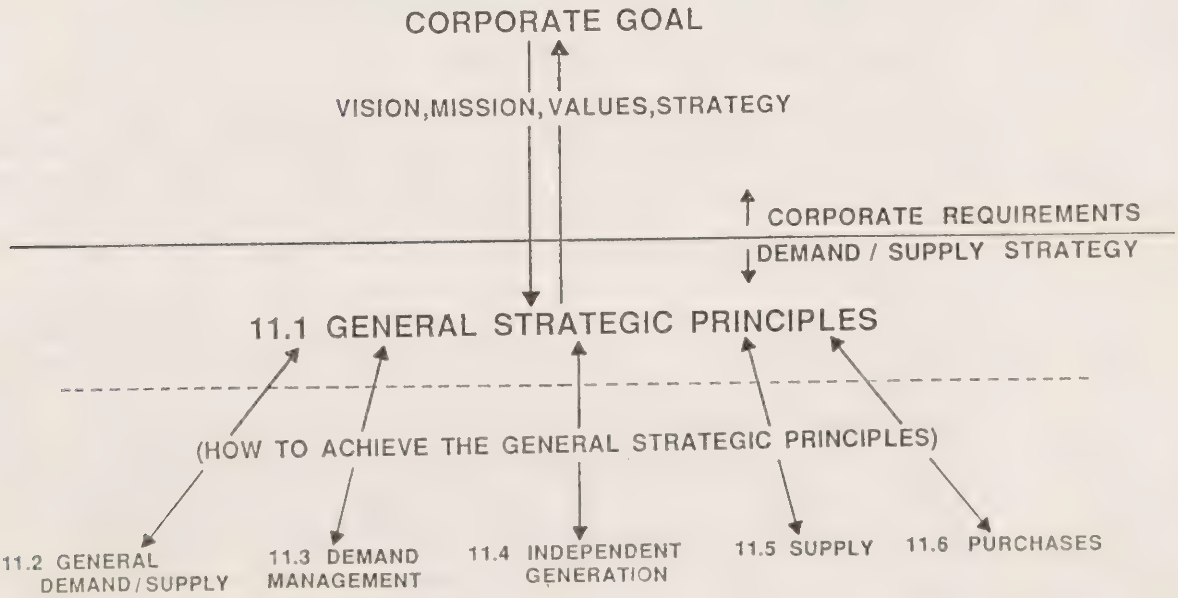
11 STRATEGY ELEMENTS

This chapter contains the proposed Demand/Supply Planning Strategy and its rationale. This strategy fits into a hierarchy of requirements (Fig 11.1). The most basic statement is the Corporate Goal which is:

> "to meet the requirements of the Ontario community for electric service, including the manner of its provision, so as to result in the greatest overall benefit to that community and in the lowest cost (customer's average unit energy cost) to the customer for that service over the long term".

Other important corporate requirements are the Corporate Vision, Mission and Values and other corporate strategies. In particular, the Corporate Values are that Ontario Hydro is committed to customer satisfaction, flexibility, reasonable pricing, responsiveness as a public corporation, and respect for employees. The five General Strategic Principles (Section 11.1) include the basic values of demand/supply planning derived from these corporate requirements. The detailed strategy consists of about 50 strategic considerations. Each statement or group of statements is followed by a discussion that draws on the material in the preceding chapters, supplementary documents and other sources.

FIG. 11.1



The strategic considerations are grouped under five categories:

General Strategies - that define specific strategies applicable to more than one type of option (Section 11.2).

Demand Management - strategies for Ontario Hydro actions to modify electricity demand (Section 11.3).

Independent Generation - Ontario Hydro strategies for generation in Ontario that is not owned by Ontario Hydro (Section 11.4).

Supply Options - strategies for Ontario Hydro owned generation (Section 11.5).

Purchases - strategies for purchasing electricity from outside Ontario (Section 11.6).

The strategy consists of all the strategic considerations and should be considered in total. The strategic considerations are summarized without discussion in Chapter 12.

11.1 General Strategic Principles

1.1 The primary objective of demand/supply programs is to contribute to customer satisfaction.

1.2 Reliability is paramount.

1.3 Low customer cost is vital.

1.4 Ontario Hydro must ensure that its activities are conducted in an environmentally and socially acceptable manner.

1.5 Rates must continue to be based on costs.

Since Ontario Hydro is a public organization which only exists to meet the needs of its customers for electricity service, customer satisfaction is the primary objective. This is reflected in the Corporate Values. For the purpose of demand/supply planning, it is necessary to define some of the elements that contribute to customer satisfaction.

In the Corporate Goal 'meeting the requirements' implies that requirements will be met reliably; reliability of supply has emerged as a key issue in public consultation and customer surveys. In particular, industrial customers identify availability of supply as the most important electricity supply issue in deciding on the location of new factories; they will not jeopardize the success of a sophisticated operation by locating where the availability of electricity supply is uncertain. Therefore reliability of electricity supply is also a key factor in the economic growth of the province. In addition, as more electrical devices are used by residential and commercial customers, loss of supply causes great inconvenience--a fact which customers clearly indicated in the survey.

Reliability of supply is seen by some to be inconsistent with low cost; if lower reliability were provided then costs might be lower. However, low reliability also causes increased problems for customers ranging from safety hazards and lost production to general inconvenience. The current reliability standards were set to balance the costs to customers of providing a reliable supply and the costs that would be caused by loss of that reliability (Chapter 2).

Customer surveys have also indicated that low cost continues to be an important objective. For residential users, it helps them to maintain and improve their standard of living. For industry and commerce, it is one of many costs that must be kept under control to remain competitive. Low customer cost responds to the Corporate Values of customer satisfaction and reasonable pricing.

It will be necessary, in some cases, to move away from lowest cost to respect environmental and societal concerns. This trade off is implicit in the Corporate Goal which has the dual objectives of greatest benefit to the community and lowest cost to the customer. This was reflected in all the consultation processes where concern for the environment was seen as being a very important issue. Many people indicated they are prepared to accept additional costs to protect the environment. This is an area where the Corporate Value of being responsive as a public corporation applies.

Supply options contribute to customer satisfaction by providing reliable, low cost supply in an environmentally acceptable way. Demand options affect these factors but also have direct impacts on how customers use electricity, the choice of electrical equipment, the thermal insulation of homes and businesses, etc. It is particularly important that demand programs be designed to be sensitive to customer concerns. For example, in Chapter 9 it is clearly indicated that demand options are acceptable to most customers only if they do not require changes in lifestyle. The demand potentials discussed in Chapter 8 are based on providing the same level of energy service with no change in lifestyle.

The Power Corporation Act requires that Ontario Hydro sell power at cost. The principles of determining costs and allocating them equitably among customers have evolved over time, and are reviewed publicly by the Ontario Energy Board. The most extensive review was the Electricity Costing and Pricing Hearing. Any proposals to change rates to encourage customers to alter their demand for electricity should be consistent with these principles. Some of the factors surrounding this are discussed in Chapter 8 and the Supplementary Document titled Rates as a Demand Management Tool. Cost based rates is another aspect of the Corporate Value of reasonable pricing.

11.2 General Demand/Supply Strategies

There are some strategic considerations which affect both demand and supply options but are more specific than the general strategic principles discussed in Section 11.1.

11.2.1 Measures of Cost

2.1.1 Ontario Hydro will aim to develop a mix of demand and supply options that provides electricity service to customers at lowest total customer cost.

2.1.2 The cost of meeting social and environmental requirements will be included in cost evaluations of demand/supply options.

The general strategic principle "low customer cost is vital" (1.3) requires closer definition before it can be usefully applied.

It is necessary to determine the appropriate measure of economic costs and savings when evaluating options. As discussed in chapter 7.2.1, there are different questions that arise when implementing demand options than when implementing supply options. For supply options, the appropriate costs include all the costs that are incurred by Ontario Hydro to produce and deliver the electricity used by customers. For demand options and independent generation, there are direct costs and savings to customers, municipal utilities and Ontario Hydro.

Given that customer satisfaction is the most important factor, it is appropriate that the measure of economic worth should be based on the total costs to all customers for electricity service (Chapter 7.2.1). The term electricity service is significant because it implies the services that electricity provides (eg, motive power, cold food, light). In this context, the costs to customers include direct expenditures by them for goods and services (eg, the cost of an electrical appliance) and also the costs incurred by Ontario Hydro and the municipal utilities to provide the electricity. The costs of the utilities are passed on to customers in general via electricity rates. This measure of total customer cost should be used in deciding whether a demand or supply program is economically desirable. If the total customer cost is reduced, then the program is worth pursuing on economic grounds. This is similar to a 'marginal cost' or 'societal cost' test. Although practical barriers may prevent all the programs that pass this test from being fully successful, this test indicates the economic desirability from the perspective of customers in total.

In attempting to minimize total customer costs for electrical service, there are many factors that affect the quality of service provided such as convenience, cleanliness, safety, controllability. These factors have value which the utility has difficulty assessing. The ultimate measure of value is what customers consider the value to be in making their energy choices.

An alternative discussed in front of the Select Committee was the 'non-participant' or 'no-losers' test. This test aims to maintain complete equity among customers by ensuring that incentives to customers who participate in demand management programs do not cause electricity rates to non-participating customers to rise above the level that would have occurred with a supply option. The Select Committee on Energy recommended against the use of this test: this strategy is consistent with this recommendation. This test cannot be applied to education programs, research projects or efficiency standards where it is not easy to identify participants and non-participants. Customer equity in financial incentives for demand management is discussed in Section 11.3.9. Equity is considered important in setting the level of financial incentives, but the proposed test (consideration 3.9.3) is one of customer acceptability and should be less restrictive than the "no-losers" test.

Many participants in the public consultation process noted the important role Ontario Hydro plays in the provincial economy. Participants believed the impact on the provincial economy, measured by effect on employment and gross provincial product (GPP), should be considered along with customer costs when evaluating options. However, provincial economic effects should not be a primary factor in Ontario Hydro decision making. It would be inappropriate for Ontario Hydro to undertake specific programs based on social and economic benefits to Canada, Ontario or a specific region; such programs are the business of the appropriate level of government.

Another area of costing that requires explicit definition is social and environmental costs. Ontario Hydro adopts measures necessary to meet all environmental regulations that affect the design, construction and operation of its facilities. As a part of good engineering practice, Ontario Hydro also adopts other measures to reduce environmental impact. The costs of meeting these requirements are included in capital and operating costs as appropriate, and are passed on to customers through rates. Hydro also attempts to cover certain social costs involved in the construction of new plant. For example, community impact agreements are negotiated with municipalities where new major generation construction is taking place. The intent of these agreements is to compensate the municipality for the added demands the project imposes on the local physical and social infrastructure. Demand options may also require expenditures to ensure social and environmental acceptability (eg, mechanical ventilation if houses are more tightly sealed). These costs are included in the total customer costs that are evaluated. Therefore, a large part of the social and environmental costs of demand and supply options are included in the costs evaluated when considering future alternatives.

11.2.2 Response to Uncertain Growth

2.2.1 The load forecast will include upper and lower projections that cover a reasonable range of possible outcomes.

2.2.2 Contingency plans must be prepared that identify practical options to respond to upper and lower load projections.

2.2.3 Demand options will be implemented, and supply options will be committed, in time to meet the most likely load growth economically and reliably.

A factor which has become of increased significance in the last decade is the need for flexibility to respond to uncertainties about the future. Load forecasts are now explicitly described by a range of possible load growths. This range consists of a most likely forecast bounded by upper and lower load growth projections. The upper and lower projections are chosen to cover a reasonable range of possible outcomes that will be considered in the planning process. Selection of this range is judgmental and the appropriate levels may change from time to time. The present load forecast range is illustrated in Chapter 4, Figure 4-7. It is estimated that there is a 20% chance that the load will be higher than the upper projection and a 20% chance that the load will be lower than the lower projection. Therefore, there is a 60% chance that the load will fall within the forecast range.

Much of the analysis of representative plans has focused on flexibility to adapt to a range of forecasts. While developing plans to meet the most likely load growth, it is important to identify the options available to meet higher growth should it occur. This might include market development, research, planning and possibly some preparatory approval work. While the options identified may turn out not to be needed, developmental work on a contingency basis may be appropriate, as there is about a 50% chance that actual load growth will exceed the most likely forecast level.

The need to identify options to meet the upper load projection must be tempered by the recognition that there is an equal chance that actual loads will be below the most likely forecast level. If capability is developed to meet the most likely or higher growth and low growth actually happens, there could be underutilized plant and unacceptably high unit costs. It is, therefore, necessary to consider the possibility of low growth.

Although early developmental work may be justified, it is unlikely that actual implementation of demand options or construction of new supply facilities could be justified on any load higher than the most probable. The developmental activities only represent a small part of the cost of an option while, once construction is started, the expenditures grow rapidly and delay or cancellation becomes increasingly expensive.

11.2.3 Resource Smoothing

2.3 To maintain flexibility and to reduce costs resource smoothing will be considered.

One of the factors that limits flexibility is the availability of financial, manufacturing, construction, and human resources. Ontario Hydro has limited capability to finance simultaneous development of many large capital intensive options. The manufacturing and construction industries can only supply limited quantities of products whether it be new generating units or insulation for electrically heated houses. Even in a time of significant unemployment, there is a limited pool of trained personnel to perform specialized tasks, such as the design of hydro-electric generating stations. Resource smoothing for both demand and supply can contribute to maintaining flexibility and to lowering costs. Plans that smooth requirements can avoid excessive costs due to sharp peaks and valleys of activity. In addition, continuing some work through the valleys help to maintain flexibility to restart to meet new demands.

Another aspect of resource smoothing is that there may be insufficient financial, human or other resources to move ahead as quickly as would be desirable in developing options for the future. Short term budgeting considerations may modify the timing of some of the actions that will be required to implement this strategy.

11.2.4 Resource Preferences

2.4 Resources meeting the basic criteria of low cost, reliability, flexibility and quality will be preferred based on the nature of the primary energy source in the following order:

- electricity efficiency, renewable energy and waste fuels;
- plentiful fuels;
- scarce fuels;

and based on their source in the following order:

- Ontario indigenous resources and electricity efficiency;
- other Canadian resources;
- foreign resources.

As noted in Section 11.1, the primary objective of demand/supply programs is to contribute to customer satisfaction. In serving the needs of customers, it is desirable not only to rely on low cost primary resources that meet reliability, flexibility and fuel quality requirements, but also that are likely to remain available over the long term and are unlikely to be subject to large increases in price.

Both long term availability and price stability are most likely in electricity efficiency improvements, renewable energy sources and waste fuels. Efficiency improvements make other primary energy resources available for other uses and users adopting improvements are unlikely to revert to older, less efficient methods. Renewable primary resources, such as hydroelectric, solar and wind power are, by definition, not consumed and are therefore available over the

long term. Streams of waste usable as generation fuel, tend to continue; they will always be available as long as the waste producing activity continues, unless technical, economic or environmental factors make their combustion undesirable. Long term availability and price stability are next most likely in primary fuels that are relatively plentiful. Coal and uranium are consumable primary fuels with resource lives measured in centuries, and so are considered plentiful. Oil and natural gas are relatively scarce, with resource lives of a few decades (Chapter 3). Thus there is a natural ranking of resources in order of renewable, plentiful and scarce. To some degree this ranking may be captured in forecasts of future prices - scarce primary fuel resources tend to have forecasts of rising real prices. However, it is not always the case that fuel price fully reflects relative long term scarcity, an example being low natural gas prices during the current short term surplus (Chapter 3).

It may also be possible to enhance long term availability and price stability by using indigenous Ontario resources (eg hydroelectric or uranium). Availability and price of such resources can to some extent be controlled within the province. Therefore, Ontario indigenous resources would be preferred. By similar reasoning there would be a preference for Canadian resources over resources from outside of Canada. Electricity efficiency options tend to have a high Ontario content and are subject to local control. In this sense they are similar to Ontario resources and should be treated as such.

These preferences are not intended to ignore differences in cost, reliability, flexibility and fuel quality, but rather to choose options once these criteria are met. In fact in some cases adhering wholly to a preference for indigenous resources can run counter to the stated objective of contributing to customer satisfaction through long term availability and price stability. For example, wind and solar power ought to be preferred since they are renewable and indigenous; the fuel cost is not going to rise and availability is not going to decline. However, very high capital costs and restricted ability to schedule power production when it is needed make it unlikely that these forms of energy would be relied upon to make a major contribution to meeting future energy needs (Chapter 8).

An additional benefit of using local resources is the potential for benefit to the provincial economy. As discussed in Chapter 8, using low cost options with relatively high Ontario content can provide substantial economic benefits in terms of employment and gross provincial product. However it is not proposed here that resource choice be determined by economic impact. Such priorities, and their attendant interprovincial and international trade issues, are more appropriately addressed by the provincial government, as Ontario Hydro's main concern is serving the needs of its customers.

No specific level of preference is indicated in statement 2.4. In many cases the preferences would support decisions that would be made on cost effectiveness grounds. In these situations, no level

needs to be specified. However, there will be instances where it will be necessary to decide whether the availability and price stability considerations dictate choosing an option that is not the lowest cost. Each such trade-off decision will have to be made on its own merits, based on the basic criteria of best serving customer needs over the long term.

11.2.5 Public Consultation

2.5 Consultation with customers, the public, governments and the legislature will continue to be an integral part of the planning process.

Ontario Hydro has a responsibility to inform and consult with people potentially affected by its plans and activities. Public input helps to ensure that the plans developed to meet customers' expected needs reflect the values and expectations of the Ontario community. In addition, public review and approval of plans for specific undertakings are required under the Environmental Assessment Act and other legislation. Cabinet approval is required before construction may start.

11.3 Demand Management

Demand Management is defined as any activity undertaken by Ontario Hydro intended to influence the amount and/or timing of electricity consumption. This includes activities that may increase demand as well as activities that are designed to decrease demand. In addition, demand can be shifted from peak to off-peak periods to reduce peak demand. Demand management strategies must be carefully coordinated to ensure a consistent thrust towards the Corporate Goal. There are many factors that are important including customer satisfaction, impact on the provincial economy, total cost, customer equity, resource conservation, flexibility and public acceptability. However, as indicated in the section on general strategic principles, customer satisfaction is considered to be of great importance to, and directly relevant to, demand management.

The following discussion of demand management strategy should be considered in the general context of corporate objectives and strategies that relate to Ontario Hydro's relationship with its customers.

11.3.1 Demand Reducing Options

3.1 Demand reducing options will be pursued to the full extent they are economic compared to the available supply options in the relevant planning period.

Reducing demand is an acceptable way of balancing supply and demand to maintain a reliable service. Studies of the potential of demand options (Chapter 8) have identified a significant quantity (1000 to 4000 MW) of increased efficiency in electrical use that could be

developed by the year 2000. These are estimates of electricity savings that could be made while providing the same level of energy service. These efficiency improvements are estimated to be economic in the long term compared to the cost of increased supply. Most of these efficiency improvements are produced by investing in more efficient equipment and are therefore likely to last for the useful life of the equipment.

The studies of representative plans have shown that development of part of this potential is consistent with reliable supply at low cost. Demand options are also judged to have relatively favourable environmental and social impacts and are generally acceptable to customers provided they do not infringe on a customer's freedom of choice or lead to significant inequities.

There are a number of intangible factors that will be considered by decision makers when assessing whether particular demand options are economic. Such factors may include flexibility, environmental and social effects, diversity of supplies, degree of dispatchability predictability, etc. To the extent that such factors can be quantified in monetary terms, they will be included in economic evaluations. To the extent they remain intangible, they will influence decision makers judgement in interpreting economic studies.

Increasing efficiency while maintaining the same level of energy service is subject to a 'law of diminishing returns'; the least expensive efficiency improvements are sought first and each subsequent improvement is more costly. Therefore, the amount of efficiency improvements that is less expensive than alternative supply options will not be limitless. Relying on demand options that are cheaper than the alternative supply options contributes to lower costs to customers in total and enhances customer satisfaction.

11.3.2 Load Shifting Options

3.2.1 Demand management programs aimed at shifting demand from peak to off-peak times will be selected to respect system limits on the usefulness of load shifting.

3.2.2 The choice between load shifting and energy storage will reflect the costs and benefits of each option.

Load shifting includes both load shifting under the control of the utility and indirect load shifting due to time-of-use rates. In practice, most load shifting would occur on a daily basis shifting load from the high load period to nighttime when load is lower.

By the year 2000, Ontario Hydro's system can only make good use of about 1000 to 1500 MW of load shifting from the 16-hour high load period to the 8-hour nighttime period (Chapter 8). If too much load is shifted, new peaks will be created at nighttime. The estimates

of the potential for loads that could be shifted exceeds the 1000-1500 MW that could be useful. Therefore, system limits rather than market potential are likely to determine the desirable quantity of load shifting.

Another way of achieving the same objective as load shifting is energy storage. Current estimates show that energy storage is relatively expensive compared to load shifting (Chapter 8). However, this relationship may be different at the time decisions are being made. The choice between load shifting and energy storage to meet the limited need to smooth load curves should be based on an evaluation of costs and benefits, taking into account the expected impacts on customers. The latest information available at that time will be used.

11.3.3 Demand Increasing Options

3.3 Demand programs aimed at increasing demand will be pursued where they provide benefits to customers in total.

Demand management includes programs to increase demand as well as programs to reduce demand. To many people it seems to be inconsistent to be pushing and pulling at the same time. However, it may be right to push in some places and pull in others. Improvements in efficiency which reduce the use of electricity should be encouraged. At the same time there are cost effective opportunities to substitute electricity for inefficient or ineffective use of other fuels and opportunities using new or existing electro-technologies to help customers to increase productivity, develop new industries etc. These uses contribute to resource conservation (Chapter 3), economic efficiency, productivity and economic growth while contributing to customer satisfaction. This was recognized by the Select Committee on Energy:

> "In some segments, growth in electricity use may benefit the province (eg, the use of thermo-mechanical pulping in the paper industry). In other segments, conservation activities are needed to improve efficiency and reduce costs".

Given that demand management will include both components, it is necessary to define the situations under which promotion of growth in demand is appropriate to avoid inconsistency.

The key to this is the value to the customer. Demand reduction is appropriate where the cost of reducing demand is less than the cost of increasing supply. By the same logic, the promotion of increased use is desirable when the value to the customer of increased electricity use exceeds the cost of increasing the supply. The value to the customer of increased use is the benefit he receives in terms of increased productivity and improved quality of life. This value is no higher than the cost of achieving the energy service with an alternative fuel after allowance for any differences in

quality of service such as cleanliness, controllability, convenience, etc. If the value to the customers of an increased use exceeds the cost of increased supply based on the total cost of new generating plant, it will be economically desirable to promote this increased use unless the system is in danger of capacity shortfalls. If the system has surplus capacity, it may be desirable to promote additional loads that have a lower value to customers provided the value exceeds the incremental cost of supply and the new load will not persist after the surplus capacity has gone.

It is frequently difficult to distinguish between load reduction and load growth demand management programs. A program that promotes increased efficiency in new uses may increase or decrease demand; improving efficiency tends to increase the market share for electricity in these applications. This distinction is not necessary as long as it is clear that the program is beneficial to customers.

11.3.4 Cooperation with Municipal Utilities

3.4 The planning and implementation of demand management options will be undertaken in close cooperation with the municipal utilities.

Ontario Hydro is not alone in supplying the electricity needs of the province. While Ontario Hydro owns most transmission and generating capacity, it directly serves only a minority of the end users of electricity. Distribution is generally the responsibility of the over 300 municipal utilities, which serve about 70% of the province's electricity needs. Clearly, demand management options will not succeed without close cooperation between Ontario Hydro and the municipal utilities.

11.3.5 Timing of Demand Management

3.5.1 Development and implementation of economic demand reduction programs should be started early enough to be effective in contributing to the most cost effective demand/supply balance.

3.5.2 Priority should be given to influencing the new market rather than the retrofit.

Demand options take time to develop and implement. They require several years for data gathering, market development, demonstration projects and program design. Once full scale implementation starts, it can take up to a decade to fully penetrate the market. Consequently, if time permits, work to develop demand management programs must be initiated ten to 15 years, and implementation five to ten years, before the full effect of the programs is required.

If time permits, implementation of demand management options aimed at reducing demand and shifting load that are cheaper than major new supply options should precede the planned in-service dates of major

supply facilities. This is desirable on economic grounds and possibly for social reasons. However, there may be circumstances where load growth is high and both are required as soon as possible. In this case, the strategy must permit the simultaneous development of demand and supply options.

Other factors also support early development. Some demand options may cost less than operating existing generating stations. These options should proceed even in a time of surplus capacity.

Early development of some demand options provides opportunities to save energy now that will be more expensive, or even unavailable, at a later date; it is cheaper to build efficiency into a new building or appliance than it is to retrofit to improve efficiency. However, an opportunity to improve the efficiency of existing facilities is likely to be available next year and in later years at about the same cost as this year. In addition, the life of a demand option is limited by the life of the building, industrial plant or appliance to which it is applied. Thus the useful life of an efficiency improvement in the new market is likely to be longer than for a retrofit. Compared to retrofitting later, efficiency in the new market may cost less and last longer and, if developed early, will capture opportunities that would be lost if development were delayed.

11.3.6 Demand Management - Research and Development

3.6.1 Technical research and market development to support existing and planned demand management programs will be given a high priority so that demand options can be efficiently implemented in a timely manner.

3.6.2 To provide flexibility, technical research and market demonstration programs shall be undertaken to provide information on the potential for new demand management programs.

There are requirements for technical research to demonstrate the technical and economic benefits of demand management. This includes the development of more efficient appliances, (eg, the northern climate heat pump), testing the effectiveness of new techniques (eg, the measurements of actual energy use in houses after upgrading the building), and the development of efficient electro-technologies (eg, plasma arc technology and microwave drying). Market research and development is also necessary to test what incentives will successfully encourage customers to improve efficiency. All voluntary demand management programs will need to be 'sold' and market demonstration programs are necessary to test customer reactions.

One message that has come from many of the U.S. utilities is that successful demand management requires careful research and demonstration programs (Chapter 8). If this is not done then money can be wasted and the programs may not achieve their objectives.

The technical research and market demonstration programs must, as a minimum, be designed to support the program required to meet the most likely load growth. However, flexibility to respond to changing circumstances has been identified as a key concern. Therefore, given the long lead time to develop and implement demand options, it would be prudent to perform additional technical research and market demonstration so that additional, possibly higher cost, demand management programs are available to respond to high load growth.

11.3.7 Demand Management - Promotion & Education

3.7 Education, information dissemination, audits, and advertising will be pursued to make customers aware of the opportunities for the efficient and effective use of electricity.

For customers to make the best use of electricity, it is important that they have information on the efficient use of electricity.

Customers are expected to increase their efficiency of electricity use without financial incentives from Ontario Hydro in order to reduce their own costs. This is called 'natural conservation'. The load forecast includes 3000 MW of natural conservation by the year 2000 (Chapter 4, Section 4.5.3). If the forecast natural conservation does not take place, there is a larger chance of electricity shortages. It is, therefore, important that the customers are informed of the energy saving options that are open to them. This requires expenditures by utilities such as Ontario Hydro on education, information, and advertising. In addition, energy audit programs can indicate to individual customers the options that they can implement in their houses, offices, shops and factories. Energy audit programs are more effective when coupled with loan or grant programs for recommended measures (Section 11.3.9).

11.3.8 Rate Induced Demand Management

3.8.1 General rates will be based on average costs.

3.8.2 Rates may be time differentiated to give incentives to shift load to off-peak periods.

3.8.3 Special rates for non-standard conditions of service may be implemented to manage demand for specific purposes.

3.8.4 Special rates should recover at least the additional cost of supplying the electricity sold under these rates.

Many possible changes to rate structures to influence demand have been suggested. These include charging 'marginal costs' instead of 'accounting costs', inverting rate structures so that small users pay lower rates than large users, giving discounts to people who use

less electricity this year than last year, charging higher rates in peak periods than off-peak periods, charging lower electricity rates to new industries to spur industrial development and equalizing electricity rates in urban and rural areas.

The Supplementary Document, "Rates as a Demand Management Tool", discussed some of the issues surrounding changes to electricity rates to encourage customers to change their patterns of electricity use. The fundamental principle remains that "Rates must continue to be based on costs" (Statement 1.5). However, within this principle there is some freedom to adjust rates to achieve demand management objectives.

Major rate structure changes are also seen to require consensus among Hydro, various customer groups, the Ontario Energy Board (OEB) and the provincial government. The most extensive public hearing on this issue was the Electricity Costing and Pricing (ECAP) Hearing in front of the OEB which lasted two years ending in 1979. As a result Ontario Hydro established four rate making objectives. The 1986 OEB report suggests that cost allocation and rate design issues should be re-examined. However, until such a review is made, it is prudent to base policy and strategy on the existing principles.

One of the important principles is that fairness is achieved by allocating costs to customers on the basis of 'cost causality'. For example, if it costs less per unit to supply larger users than smaller users, the rates for larger uses should be correspondingly lower. Many of the proposals for rate change run counter to this principle eg, inverted rates, discounts for reduced use, discounts to new industry, equalizing rural and urban rates etc.

The application of this principle requires that costs be allocated between different classes and generations of customers on a fair and equitable basis. The policies that govern this are outside the scope of this document because they are not directly relevant to the Demand/Supply Planning Strategy.

There was extensive discussion at the OEB's ECAP hearing as to whether electricity rates should be based on the marginal cost of new supply rather than accounting costs which include the costs of new and old facilities. The OEB clearly recommended against marginal cost pricing and rates "because of major problems of definition, determination, and implementation". Therefore general rates are calculated based on average costs.

However, the OEB did recommend that time differentiated rates be introduced. Time differentiated rates based on the higher costs of supplying load in peak periods, are consistent with the principle of cost tracking and can contribute to the objective of encouraging the efficient allocation of resources by giving customers an incentive to move loads from peak to off-peak periods.

In addition to the general rate structure Ontario Hydro has special rates for categories of power with different conditions of service. Interruptible power is sold at a discount to major customers who can accept the lower quality of service. Special rates can be an important tool in implementing demand management, particularly direct control load management.

Fairness still requires that special rates cover at least the costs caused by supplying the additional electricity that is sold under these rates.

11.3.9 Financial Incentives for Demand Management

3.9.1 Incentives should be high enough to encourage the development of a large part of the potential that is beneficial to customers in total.

3.9.2 Customers who participate and receive direct benefits should provide a substantial contribution to the cost.

3.9.3 The level of incentives should be acceptable to customers in general.

3.9.4 Financial incentives should be based on lifetime benefits; loans and grants may be used to increase the return to customers in early years.

Ideally, information programs and appropriate rate structures would be sufficient to induce the optimum level of electrical energy efficiency through market forces. However, factors that tend to prevent the implementation of some cost effective electrical efficiency measures include:

- limited financial resources of customers;

- customers require a shorter payback for an investment in efficiency than a utility requires for an investment in supply;

- the marginal cost of increased supply to the utility may be higher than the average accounting cost that is reflected in rates to customers;

- the customers who pay the electricity bills may not be responsible for the energy efficiency of buildings and equipment;

- the customer may have different priorities to those evaluated by the utility.

Financial incentives such as loans or grants can help to overcome these barriers. A number of alternative strategies must be considered for this area:

- no financial incentives but rely on promotion and education;

- loans which would be paid back by customers;

- grants to cover part of the cost of efficiency improvements;

- grants to cover the full cost of efficiency improvements.

A policy of giving no financial incentives could be selected if it were judged that a utility has no business making loans and grants to influence what customers do with electricity. Giving loans and grants could be seen as an inappropriate distortion of the free market. However, as discussed above, the market does not always operate in a perfect manner. There seems to be wide public acceptance of the utility influencing demand provided that the programs are not mandatory.

In addition, it may be argued that Ontario Hydro can best contribute to the efficiency and prosperity of Ontario by concentrating on the business of supplying electricity in the most efficient way. In this view, demand management is best done by governments because it is so closely intertwined with policy for other fuels and with wider social policy. However, the Ministry of Energy has indicated that Ontario Hydro and the municipal utilities have important roles in implementing strategic conservation (An Energy Efficient Ontario - Toward the Year 2000, published in 1986). Therefore, a policy of no financial incentives may be inappropriate.

A policy of making loans to customers is probably the least costly form of financial incentive. The costs of such a program are mostly administrative. Ontario Hydro has made loans to customers (eg The Residential Energy Audit Program) to encourage efficiency improvements. Ontario Hydro should go at least this far in providing financial assistance to customers.

In many cases loans will not be enough to encourage a large proportion of the efficiency improvements that are economically desirable. Customers are reluctant to get into debt. Low interest rate loans may tip the balance in favour of options that customers were already considering, but are unlikely to induce major changes in decisions. If a large proportion of the economic potential is to be achieved, it is probable that part of the cost will have to be paid by a public body such as Ontario Hydro in the form of a grant.

Determining the level of grant or other financial incentive is subject to a number of possibly conflicting requirements. One of these requirements is that the incentive should be high enough to encourage a large part of the economic potential.

Grants to cover the full cost of energy efficiency improvements are the highest level that should be considered. Proponents of full grants argue that, if an energy saving option is cheaper than an energy producing option, the utility should be prepared to pay the full cost of the energy saving option, just as it would have paid the full cost of the energy producing option. However, there are a number of reasons why full grants should not be made:

- energy saving and energy producing options are different from a financial point of view. Investment in energy producing options results in assets owned by the utility that will earn revenue to pay off their cost. The benefits of energy saving options go to the participating customers and the utility receives no revenue to pay off the grants. Full grants can result in higher electricity prices as shown in the analysis of representative plans.

- a full grant should not be necessary to encourage cost effective options; previous government grant programs, which had substantial success, did not make full grants. For example, the Federal Government CHIP program paid about half the cost. Since the government grant was taxable the effective incentive level was 25-50%.

- it is only equitable that the participating customers who receive the benefit of lower electricity cost should contribute a substantial part of the cost. Otherwise grants may be seen as 'give aways' of customers' money (see Chapter 9, Sections 9.5.11 and 9.8);

- if a customer is not prepared to invest any money in an energy saving option which the utility estimates will save him/her money and provide the same energy service, it is likely that the option runs counter to some other objective that is valued by the customer but has not been evaluated by the utility. Customer concerns that may not be included in utility evaluations can include the customers' perceptions of safety, convenience, controllability, air quality, value of space, as well as aesthetics. Customer satisfaction is the most important factor in demand management and customer values must be respected.

- high levels of incentive may introduce unwanted market distortions in addition to the desired effect. For example, large incentives for improved insulation in new electrically heated houses will probably greatly increase the market share of electricity, have the net effect of increasing electricity demand and be considered unfair marketing practices by the gas companies.

There may be cases where Statement 3.9.2 does not apply because the customers who participate do not receive substantial direct benefits. For example, a load shifting option does not reduce the customers use of electrical energy and the customer will not see a benefit if the electricity rates are the same for day and night.

The requirement for customer contributions can be applied in conjunction with Statement 3.9.4, which permits increased return to customers in the early years, to reduce the possibility of the requirement for customer contributions preventing the implementation of economic options.

Another important factor in deciding on the level of incentives is customer equity. If incentive levels are high, then the participating customer may receive benefits that exceed the total benefits of the option. In this case, there would be an increase in electricity rates and increased costs to non-participating customers.

In surveys, customers objected fairly strongly (73%) to the idea of financial incentives that would increase the long-term price of electricity. However, there is also widespread support for financial incentives even if the customers themselves will not receive them. Clearly there is a need to balance the conflicting objectives of encouraging the economic efficiency improvements while avoiding significant inequities.

Concerns about possible inequities can be reduced by careful implementation of demand management. If a wide range of programs is offered, most customers can be participants. Alternatively, if a program is restricted to one class of customers, it may be possible to recover the costs from only that class by adjusting the rates to that class. The cost of incentive programs will undoubtedly be discussed at Ontario Energy Board rate hearings. This is one forum at which customers' views on the equity of rate forms and incentives can be heard. The important factor in considering customer equity is whether the degree of equity is acceptable to customers. If the customers perceive the rates they pay as inequitable, customer satisfaction will not be achieved. Customers have, in the past, accepted deviations from the strict definition of customer equity. For example, the costs of supplying electricity are higher in northwestern Ontario; yet uniform rates have been accepted despite the cross subsidy from the rest of the province. However, seasonal time-of-use rates were rejected because of a perceived inequitable treatment of the north. Ontario Hydro must continue to be sensitive to customers' concerns regarding the equity issue.

An important question in designing incentives is whether the incentives should be matched to the benefits on a year by year basis. If Ontario Hydro paid the benefit experienced each year, the incentive would be spread over the life of the option. This would provide the best matching of incentives and benefits but would not permit grants towards the capital cost and other financial incentives that are 'front end loaded'. Paying out most of the incentive up front is likely to be more effective in overcoming the customers' reluctance to spend capital and thus be more effective in reducing inefficient electricity use. In addition, since supply options are evaluated on the basis of their lifetime costs, there is no reason why demand options and demand incentives should not also be evaluated on the same basis.

The strategy that is proposed above has conflicting requirements and will require careful application to individual programs. If loans alone are sufficient to encourage a desirable option, loans alone would be appropriate for that option. However, other cases may

require other financial incentives such as direct grants. The selection of the level of financial incentives will require careful balancing of the requirements of Strategic Considerations 3.9.1 to 3.9.4.

11.3.10 Energy Efficiency Standards

3.10 Ontario Hydro will work with governments, industry and customers towards developing standards for buildings, appliances, etc, including the highest electrical energy efficiencies that are widely acceptable.

Energy efficiency standards can be applied to buildings or to appliances, motors and other types of electrical equipment. Standards have certain advantages and have been used in the past. Electrical standards have been set by the Canadian Standards Association (C.S.A.) and building codes set by various levels of government. In setting standards, energy efficiency is only one of a number of considerations. For instance, the primary concern of the C.S.A. in setting electrical standards is safety. The advantages of mandatory standards in achieving increased energy efficiency are:

- they can achieve a high degree of penetration.

- they can be effective in situations where market forces and financial incentives are ineffective because the party that makes the decisions about energy efficiency does not have to pay the resulting energy bills.

- they may not involve large expenditures by the utility for implementation.

However, energy efficiency standards could conflict with other priorities. Most people do not want demand management to be mandatory and to restrict their freedom and lifestyle. Manufacturers of electrical equipment have strong interests in standards that will affect what can be produced and sold in Ontario. Builders become concerned about changes to building codes that could affect whether their houses are attractive in the market place in terms of price and other factors. Energy efficiency standards for buildings should be developed to cover all energy forms and not just electricity. Therefore mandatory energy efficiency standards must be developed taking into account the full range of interests that are affected. Since the range of interests goes far beyond the concerns of an electrical utility, standards are best set by agencies such as governments or standards agencies.

The Select Committee on Energy recommended that the Ministry of Energy should take the lead role in energy efficiency standards. Recently the government announced their intentions to introduce a new energy efficiency act. The act is to provide for higher standards of efficiency for applicances and heating and cooling

equipment. The energy conserved by improved efficiency standards for appliances would be modest (around 100 MW). Improved standards for appliances and equipment are useful, but they are not sufficient by themselves. Other demand and supply options are needed.

Ontario Hydro has had an active role in the past in supporting the development of energy efficiency standards by the C.S.A. and others. In the future, Ontario Hydro will continue to support such activities.

11.3.11 Other Barriers

3.11 Ontario Hydro will identify other barriers to increased efficiency and work with other parties as appropriate towards the reduction or elimination of such barriers.

There are other barriers to implementing desirable electrical efficiency measures that may not be adequately addressed by research, information programs, changes to rate structures, financial incentives or standards. Some of these barriers may be known, such as the lack of incentives for tenants to save electricity in bulk metered apartments. Other barriers may be identified in the future, in the course of market development programs. In most cases the reduction or elimination of these barriers will require a cooperative effort by Ontario Hydro and other interested parties. It is not possible at this stage to identify all the potential barriers and to specify the appropriate strategies to deal with them.

11.4 Independent Generation

4.1 Rates for purchasing power from independent generators and incentives for independent generation projects shall be up to the avoided cost to the system as a whole.

4.2 Rates and incentives for independent generation may vary because avoided cost depends on many factors, including the reliability, timing and location of the deliveries.

4.3 Ontario Hydro will regularly communicate the need for independent generation to potential independent generators; request proposals to contribute to that need; and negotiate detailed terms and conditions with suppliers whose proposals have potential to satisfactorily meet the need.

4.4 Ontario Hydro will establish standard rates for purchases of independent generation having a capacity of five megawatts or less. The standard rates for hydroelectric or other renewable sources will be set at the full avoided cost.

Small, alternative, non-conventional generating sources that are owned and operated by Ontario Hydro are a supply alternative which can be evaluated and implemented by Ontario Hydro in the same way as other supply alternatives (Section 11.5.6). However, many of these sources will be owned by private individuals or companies and are defined in this document as independent generation. Although these options are technically supply options, their implementation requires actions by others, mostly customers. The indirect means of encouraging implementation are similar to the means of encouraging demand options. Therefore independent generation requires separate formulation of strategy recognizing that it has characteristics similar to both supply and demand options.

Some independent generators use their output to supply part of their own electricity needs. Others wish to sell all or part of their generation to Ontario Hydro or the municipal utilities. Either arrangement may lead to lower total costs than alternative supply facilities and policies and practices must be sufficiently flexible to encourage both self generation and the purchase of power from independent generators. This will require a combination of rates for the purchase of power and other incentives such as low interest loans.

Ontario Hydro uses avoided cost as the upper bound on purchase rates and incentives. Avoided cost is defined as the cost incurred by Hydro if Hydro was to provide the power purchased from the independent generator. Therefore, avoided cost is dependent upon the options available to Ontario Hydro in meeting electricity demand. Avoided cost reflects the value of the power to Ontario's electricity system. Purchase rates or incentives higher than avoided cost would increase electricity costs to customers and could not be justified without some additional benefit.

Some projects can produce power for sale at costs well below the avoided system cost. Between the bottom line of production costs and the top line of avoided cost there is room to establish a fair purchase price. This fair price is one that provides an adequate return on investment for the independent generator while maintaining the objective of providing power at the lowest cost. This is in the best interests of the electricity customer.

The avoided cost varies according to the degree of dependability of the delivery. Some independent generators deliver energy occasionally when it is surplus to their own requirements. For example, producers of hydraulic power may have a surplus when water flows are high. This helps to reduce Ontario Hydro's fuel consumption but does not reduce the need for new generating capacity because it cannot be depended on at peak load times. Other generators supply power on a regular and dependable basis. In this case, the need for new generating plant is reduced and the avoided cost is higher.

Just as the cost of supply tends to be higher in the daytime than at night and higher in winter than other seasons, so avoided cost varys with time in much the same way. If these time variations are reflected in the rates and incentives for independent generation, it will encourage production by private producers when the electricity has the highest value.

Some independent generation will have higher avoided cost because its particular location leads to a reduction in transmission costs as well as generation costs.

For independent generation to have full value to reduce the need for new generating plant there must be a high probability that the independent generation will be available and economic for several decades into the future. This is very hard to analyze and place a specific value on because of the uncertainties that far into the future. However, this long term economic viability is significantly affected by the type of primary energy source used. Hydroelectric and other renewable and waste fuels are likely to continue to be available for the foreseeable future. However, much of the cogeneration potential would require the use of oil or natural gas. These fuels are relatively scarce and there is a substantial probability they will not be available in the long term as an economical fuel for electricity generation. In the promotion and selection of independent generation, preference will be given to hydroelectric and other renewable sources.

Ontario Hydro must deal with independent generators in an effective and business like way. It is important that potential independent generators know what Ontario Hydro's needs are for independent generation. This can be communicated to them in a regular request for proposals. This request could indicate the quantities and timing of system needs. It could also give a general indication of the range of avoided costs, the factors that would add to, or reduce, the value, and the types of rates, incentives and technical assistance that could be available. This request would assist potential independent generators to prepare proposals that closely match system requirements and have a good chance of being acceptable.

The process of requesting and receiving proposals is unlikely to remove the need for individual negotiations with each independent generator. Each independent generation project generally has unique circumstances. For example, the independent generator may want Ontario Hydro's contribution to be structured as a combination of a low cost loan, a repayment schedule, and a guaranteed rate that suits his particular financial requirements. Ontario Hydro may want conditions on timing and operating pattern that enable the independent generator to be coordinated with other parts of the generation and transmission system. Proper coordination with the

rest of the system will increase the value of the independent generation and may permit increased incentives. For example, there are areas of the main system, such as northwestern Ontario, where supply costs tend to be high due to long transmission distances and low population densities. Higher incentives have been justified for cogeneration in this area, based on transmission savings.

The negotiations with each independent generator should lead to individual contracts that provide a better match between system needs and independent generator needs than can be obtained through the generalised request for proposals. This process should be effective for larger independent generators where each project can have a significant effect on the power system and where there are substantial amounts of electricity and money involved.

However, standard purchase rates may be appropriate for buying power from the small independent generators. In this context small would be generation with a capacity of five megawatts or less. This approach ensures fair treatment to all independent generators. It also lets them know the value of the power, allowing for a fair assessment of the project at the outset. There are many small independent generators currently selling power and many more are possible. While each generator may have varying circumstances that could result in a value different from the uniform rates, it would cause disadvantages to establish individual price contracts. More people would be required to negotiate contracts. The administrative cost would be out of proportion to the value of the energy supplied. The time taken to establish contracts would increase significantly, perhaps becoming too long to retain the interest of the independent generator. Uniform purchase rates for small independent generators are more efficient and mutually beneficial. In order to apply the general preference for hydroelectric and other renewable sources, the standard rates for these will be set at the full avoided cost.

11.5 Supply Options

The strategy for supply options covers all generation owned and operated by Ontario Hydro including existing and new hydraulic, fossil fuelled and nuclear plant as well as smaller generating sources such as solar or wind power.

The analysis of representative plans (Chapter 10) shows that economic demand options and independent generation are unlikely to be sufficient for the next 20 years based on the most likely load forecast and are certainly not sufficient to meet higher load growth. Therefore, this strategy must consider the supply options.

11.5.1 Supply General

5.1 Major increases in supply will be provided by the lowest cost supply or purchase options available to meet the need after allowing for the effects of demand management and independent generation.

Implicit in this consideration of the selection of the lowest cost major supply option is that it is an available option. This requires that it first meets other requirements that could eliminate it as an option. Foremost of these requirements is that the option be socially and environmentally acceptable, consistent with the General Strategic Principle 1.4.

The supply options that have been studied have a variety of costs, lead times, potentials, and other characteristics. Some of the supply options, such as wind and solar, may make useful contributions in some situations but, due to limited potential, will not make a major contribution when a substantial increase in supply is required (Chapter 8). The major contributions to increased supply are likely to come from some combination of fossil fuelled, nuclear, and to a lesser extent hydraulic plant. Purchases under the right terms would be an acceptable alternative to major supply additions (Section 11.6). The study of representative plans shows that, given enough time for approval and construction, the lowest cost plans include additional nuclear capacity. However, the plans also show that there are circumstances where additional fossil fuelled plant is desirable. For example, the option of Integrated Gasification Combined Cycle (Supplementary Document - The Options) provides flexibility by giving relatively quick additions to supply burning natural gas or oil that can be subsequently converted to coal gasification.

The choice of options to meet the need for major increases in supply will be made based on the most economical choices that are environmentally and socially acceptable as seen at the time that decision must be made. This evaluation will take into account the timing of the need, and whether the need is seen for both energy and capacity. It is not possible to be specific at this time as to what option will be chosen. Choosing supply options will require decision makers to consider not only economic studies, but also to apply judgement to ensure that appropriate weight has been given to intangible factors such as non-quantifiable aspects of flexibility, environmental impact, dispatchability, diversity, etc.

11.5.2 Supply Approvals

5.2.1 Ontario Hydro will seek improvements to the planning approval process to provide increased flexibility.

5.2.2 Approval for new transmission to incorporate new generation shall be sought as part of the generation approval process.

There are many government regulations and control processes to ensure that Ontario Hydro's activities are in the broader public interest. In particular, before building new supply facilities there must be an environmental assessment. The decision to construct new facilities is not taken by the Ontario Hydro Board until after the environmental approvals have been obtained. This

decision must be confirmed by the provincial government by an Order in Council before orders can be placed and construction work can start. The approval process together with other necessary studies can take five to eight years. The construction or acquisition phase can take another five to eight years.

The planning approval process is intended to ensure that the most beneficial developments proceed taking into account environmental, social, technical and economic factors. The process includes a public hearing, if the Minister of Environment deems a hearing desirable. While this process has worked well for many small projects which only affect a limited area, it is not clear that the process is adequate for major generation and transmission projects. The experience with locked in energy at the Bruce Nuclear Power Development (Section 2.4.6) has demonstrated the length of time and unanticipated delays and cost penalties that can be involved. It also suggests that new generation and the new transmission facilities required to incorporate it should both be dealt with in the same approval process.

The length of the approval process together with the construction time of major projects reduces the flexibility to respond to changes in forecasts of future conditions. An approval process that lengthens the effective lead time for decision making from a construction time of five to eight years to a total of ten to 16 years also reduces the effectiveness of planning. Much less is known about the future ten to 16 years ahead than five to eight years and so forecasts are less reliable and planning decisions are more likely to be inappropriate.

There are strategies that could possibly contribute to improved planning flexibility while maintaining the proper and open consideration of environmental and social issues. These include approval banking and separate approvals of environmental acceptability and need. It is not clear at this time what improvements can be made in the process. However, it is clear that there is a risk that the length of the process and the potential for delay will cause unnecessarily expensive and less environmentally desirable options to proceed because approval and construction of the more desirable options could not be completed in time.

To correct this situation, Ontario Hydro is proposing to work with the provincial government and other interested parties to determine what improvements can be made in the planning approval process.

11.5.3 <u>Unit Sizes, Plant Size and Flexibility</u>

5.3 Single or two unit commitment of economically sized units in multi-unit stations will be considered to maintain flexibility.

It has proved economic in Ontario to build nuclear and coal-fuelled generation with unit sizes of about 500 to 1000 MW, with four to eight units per station. There seems to be little or no economic

benefit in going to larger sizes. The economic size of units in hydroelectric plants is highly variable and depends to a large degree on the site. Some views have been expressed that large multi-unit generating plants add capacity in increments that are too large to be quickly absorbed and thus leads to poor flexibility to respond to changing circumstances. However, the analysis of options (Chapter 8) shows that reducing the size of coal or nuclear units to the 200 MW to 300 MW range substantially increases costs, which are further increased if single unit stations are used. Furthermore, analysis of representative plans (Chapter 10) shows that a strategy of depending on small distributed generating plants near to load centres leads to increased costs; difficulties in meeting acid gas emission regulations; and difficulties in finding enough sites and transmission routes for many small generating plants near the main load centres in the Toronto area. This increase in cost is not justified by the value of the increase in flexibility when considering how plans respond to load growth different from the forecast. The problem is how to achieve the economic benefits of large multi-unit stations without leading to unacceptably low flexibility.

When looking at this question, it must be recognized that the Ontario Hydro system is a large system which has 20,000 MW of load requiring about 25,000 MW of generation. These figures are likely to grow by about 50% over the next 20 years. While a four unit station like Darlington adds about 15% of required system capacity, a single 500 - 1000 MW unit represents only a 2% to 4% increase in capacity. One unit of economic size is a small increment to the Ontario Hydro system, comparable to one year's growth in load.

In the past, when several units were required in a short period of time, commitments were made and orders were placed for all units in a multi-unit station at the same time. This is not necessary; Lakeview, Lambton and Pickering A generating stations were committed in pairs of units. It is possible to achieve most of the economies of multi-unit stations by staged commitment of one or two units at a time while preserving flexibility to slow down or cancel later units.

11.5.4 Site Acquisition

5.4 New sites for major generating plant shall be sought to allow generating stations of economic size to be built while maintaining a geographical balance of electricity demand and supply.

The need for major generating station sites is closely intertwined with transmission system considerations; if generation is sited a long way from the load there will be increased needs for transmission and increased costs. To minimize total system costs, it is desirable to maintain a rough balance in load and generation in broad areas of the Province. (Chapter 9). At present, sites

owned by Hydro that are suitable for economically sized fossil or nuclear plants are not well distributed across the province. It is important to acquire new sites so that when major new generation is required this balance can be maintained.

11.5.5 Existing Plant

5.5.1 A high priority should be given to maintaining and improving the performance of the existing supply facilities.

5.5.2 Rehabilitation or redevelopment of existing facilities should be assessed along with the other demand and supply options.

5.5.3 To provide a flexibility margin, consideration should be given to retaining in a preserved state existing plant that has reached the end of its useful life.

Existing generating facilities will continue to be the largest category of generating plant over the 20 year planning period. Even at the end of that period existing generation will be more than two thirds of the total. As indicated in Chapter 6, the existing plant is aging and increased efforts will be required to maintain the capability of these plants. In addition, improvements at existing plants can be an economical way to reduce the need for new facilities. Ontario Hydro has replaced turbine runners in 45 hydroelectric generating units in the last 10 years increasing their dependable capacity by 180 MW. The increase in the ratings of nuclear units at Bruce A and Bruce B nuclear generating stations by over 400 MW in total should be completed by 1990. Clearly these efforts should continue.

As existing units age they can require new expenditures to prevent them from becoming unsafe, uneconomic, or environmentally unacceptable. The alternative would be to shut down plant. However, it is frequently more economic to rehabilitate or redevelop old generating plant than to build replacements; two of the least costly hydroelectric opportunities, the Mattagami and Niagara schemes, are redevelopments; one of the least expensive options for coal-fuelled plant is to convert the Lennox oil-fuelled plant to coal; adding limestone scrubbers to existing coal-fuelled plants is likely to be undertaken by the mid-1990's to help meet acid gas emission regulations; and rehabilitation has been successfully undertaken in the past at a number of stations. The need for rehabilitation and redevelopment is likely to increase in the future as the existing units age while fewer new units are added. Sometimes the need for major rehabilitation provides an opportunity to economically increase output, improve efficiency, or make other improvements. These opportunities should be pursued.

Sometimes a plant reaches a point where continued operation is unacceptable and rehabilitation or redevelopment does not seem worthwhile; it would be more economic to replace it with cost effective new plant. At this point, if one could predict the future

with certainty the proper decision would be to decommission and dismantle the old plant. However, old plant may still have value to provide flexibility to cover uncertainties in future load growth. It is often possible to recommission an old plant much more quickly than a new plant could be built. The old plant may still be expensive to operate but cheaper alternatives may not be available. Therefore, a relatively inexpensive strategy to enhance flexibility to accommodate increased load growth is to maintain obsolete old plant in a mothballed state rather than to decommission it.

11.5.6 Alternative Generation

5.6.1 Ontario Hydro will continue to investigate the technical and economic feasibility of alternative generation sources, particularly those that use renewable and Ontario resources.

5.6.2 Ontario Hydro will implement alternative generation sources in specific situations (eg, isolated systems) where they are the most beneficial alternatives.

This section discusses the strategy for non-conventional small generating options that would be owned and operated by Ontario Hydro. Section 11.4 discussed the strategy for generation including non-conventional generation that others would own. Ontario Hydro undertakes research and development into many sources of generating power including solar and wind power and also keeps abreast of the results of research and development by others. This allows Ontario Hydro to use these technologies in special applications to which they are suited and to be in a position to advise potential private generators who might want to use these technologies. It also allows early identification of situations where technological and economic developments are likely to make new techniques commercially viable on a large scale. Technologies that use renewable and Ontario resources should be given preference consistent with the general strategy given in Section 11.2.4.

There is wide public support for implementing options such as wind and solar. However, it is not clear that the public is aware of the economic and environmental implications of widespread application. As indicated in Chapter 8, even with projected cost reductions due to continued development, wind and solar are likely to be about twice the cost of conventional supply options. Large scale implementation would not be consistent with the public's desire for low cost power. The visual impacts on the landscape of large numbers of windmills are likely to be more severe than the effects of transmission lines. Both solar power and wind power require large areas of land which may not be available close to large load centres. Both of these technologies require energy storage or backup from other sources in case the wind is not blowing or the sun is not shining when power is needed.

However, there are specific applications where these options can compete; photovoltaic solar, wind power and small hydraulic are

being installed by Ontario Hydro in remote communities and will be used to replace diesel generated electricity. Experience gained in designing, installing and operating these facilities builds upon and complements the knowledge from R&D activities. This is an important activity that should continue. It is necessary to build capability in this area to continue with the special situations that are economic today and to quickly apply new technologies if a major technological breakthrough does occur.

11.5.7 Hydraulic

5.7 The economic hydraulic developments should be undertaken in an orderly program.

Hydraulic generation provided almost all of Ontario's electricity until the 1950's. Existing hydraulic plants continue to provide about 30% of electricity needs with a high degree of reliability and at a low cost. In addition, the public has adjusted to the environmental changes produced by these plants. In the future, with adequate maintenance and rehabilitation, these plants are expected to continue to make a valuable contribution to electricity supply.

This good experience with existing hydraulic generation has influenced public opinion with respect to new hydraulic developments. Many people prefer new hydraulic development believing that it is environmentally benign, cheap, available and good for the economy because it is an indigenous, renewable resource. These beliefs are not all consistent with technical analysis nor are they all supported by environmental groups. Experience shows that proposals for new hydroelectric plants draw objections on environmental grounds.

The strategy for new hydroelectric development must not only respond to the spirit of the public input but must also be consistent with the technical, environmental and economic considerations. The public appears to be aware that the operating costs of hydroelectric plants are very low and that existing hydroelectric plants provide very low cost electricity. However, the best sites have already been developed. Therefore new hydroelectric stations would have higher lifetime energy costs. Many people may not be aware of the relatively small economically and environmentally viable potential for additional development.

Hydroelectric development does use Ontario based renewable resources and should qualify for preferential treatment under the Ontario preference indicated in Section 11.2.4. The relatively small size of new hydraulic plants is appropriate for some of the areas, eg, Northwestern Ontario, where they are situated.

As indicated in Section 11.5.5, it is important to maintain, improve and rehabilitate existing plant. This is particularly true for the hydraulic plant because of the increasing age of the plant and the continuing and renewable nature of the resource.

There are also some new hydroelectric developments that could be developed. As indicated in Chapter 8 and the Supplementary Document "The Options", the identified practical potential is about 1000 to 2700 MW of peak capability. As most of those developments would be peaking plants the average energy output would be about 250 to 700 MW, a figure roughly equivalent to the energy output of one Bruce nuclear unit. Some of these sites are comparable in cost to the major nuclear and coal supply options and it is necessary to have a process of selecting new sites and determining the appropriate timing. In 1978, Ontario Hydro started a program to identify and develop new hydroelectric stations. Early in the process it was recognized that the efficient way to develop their potential is with an orderly program of developing sites and river systems that provides a reasonably smooth flow of work to engineering consultants, manufacturers and construction companies (Section 11.2.3). To date three developments have progressed beyond the stage of preliminary studies - Little Jackfish, Mattagami redevelopment and Niagara redevelopment. Other projects are being studied and some may prove to be sufficiently economic to proceed. Although these projects are not likely to meet the bulk of future needs they can make significant contributions and should be developed.

11.5.8 Nuclear

5.8 Ontario Hydro will seek to maintain CANDU nuclear so that it is available for future development.

Public views regarding the merits of nuclear power range from strong support to strong opposition. The major debates are over safety and environmental issues surrounding the full nuclear cycle. There are additional concerns regarding economic issues such as high capital costs and the associated impact on debt (Chapter 9). The merits of nuclear power are the expected low cost of energy over the lifetime of the plant, high air quality compared with combustion-based generation and the use of indigenous resources. Apart from demand options which increase the efficiency of use of existing resources and limited hydroelectric, nuclear power is the only indigenous option capable of further major development (Chapter 3).

The safety record of nuclear power in Ontario is very good. Ontario Hydro aims to keep emissions from the stations below 1% of the permissible levels set by the Atomic Energy Control Board; these targets have been met at every station for every year of operation.

Safety concerns were extensively reviewed by the Select Committee on Ontario Hydro Affairs in 1980. The Committee concluded that Ontario Hydro's CANDU stations were acceptably safe. However, the recent accident at Chernobyl in the USSR has renewed public concerns and the more recent Select Committee on Energy has recommended a further review of nuclear safety (Chapter 9.10). The provincial government

has accepted this recommendation and appointed Professor F.K. Hare to conduct a review of the safety of the design, operating procedures and emergency plans associated with Ontario Hydro's nuclear generating plants.

Chapter 5 indicated the degree of Ontario's dependence on nuclear power. Including Darlington, it will represent 42% of the system capacity and 60% of the system energy produced. These existing plants already make a large contribution to maintaining reliable, economic power in Ontario. It is vital that efforts continue with other responsible bodies such as Atomic Energy of Canada Ltd and the Atomic Energy Control Board to maintain the safety, and reliability of the existing plants so that they can continue to supply power safely, reliably and economically. This supports Strategic Consideration 5.5.1 which indicates the high priority to be assigned to maintaining the capability of existing plant.

Depending on the circumstances at the time, nuclear may be selected as a preferred supply option when major new supply is foreseen to be required (Strategic Consideration 5.1). However, as indicated in Chapter 10 there is a risk that the capability to build CANDU nuclear plant will be lost if action is not taken to maintain the option.

In deciding whether action should be taken to prevent this loss of capability it is important to see whether more nuclear is likely to be desirable within the context of this strategy as a whole.

The studies show that nuclear is expected to be the lowest cost option for major energy supply. The analysis of representative plans (Chapter 10) shows that the lowest cost plans for both the most likely and upper load growth scenarios include nuclear plant. Unless load growth is low, all plans without new nuclear end up with increased reliance on coal resulting in cost penalties estimated to be $5 to $10 billion (1985 present value) and increased difficulty in meeting acid gas emission regulations. The eventual result of a no nuclear strategy is increased dependence on resources (mostly coal) from outside the province, increased difficulties in meeting acid gas emission regulations and probably increased costs. Such a strategy would not be consistent with the general strategies of low cost electricity and preference for Ontario resources.

Another consideration is whether further nuclear development creates too heavy a dependence on one technology. Some people perceive nuclear power to be too new or too unreliable to constitute a major portion of the system. If there were other alternatives that were almost equally beneficial, diversification would be attractive. Demand management, independent generation and new hydraulic generation can make a contribution to diversification at acceptable cost. However, when major energy supply is required, the primary alternative is coal which has its own distinct disadvantages. As indicated above, non-nuclear strategies to reduce dependence on one technology tend to be expensive.

There are a number of reasons why further nuclear dependence might be acceptable and that if major problems were to occur they could probably be managed. The CANDU system has been in use for about a quarter of a century and is no longer a 'new' technology and there is diversity between nuclear units as designs have evolved from Pickering NGS A to Darlington NGS. Therefore, generic faults common to the whole system are unlikely and an existing weakness that might be common to more than one unit or station would likely require outages to different units at different times. Even after the loss of a whole nuclear generating site most of the energy loss could be made up from emergency purchases and increased production from coal provided the provincial government temporarily waived acid gas emission regulations. (See Chapter 10 reference report: Discussion of Resource Diversity).

Another concern about nuclear development that was expressed in the public consultation program is the high capital cost of nuclear plant and the associated impact on debt. The public concern about debt appears to be partly based on a number of misconceptions. These were dealt with in some depth in a presentation to the Select Committee on Energy by the Chairman of Ontario Hydro, called Overview of Electrical Service in Ontario, September, 10, 1985.

This speech shows that Ontario Hydro's debt is not out of line when compared to the value of Ontario Hydro's assets, Ontario Hydro's debt over the last 60 years, and the debt of other large public utilities.

In addition, high capital costs and debt are not exclusively nuclear issues. The capital costs of coal-fuelled plant with emission controls are about three quarters of the cost of nuclear plant. Hydroelectric power, solar and wind usually have higher capital costs per unit of output than nuclear.

The analysis of representative plans included financial analysis indicating that the borrowing requirement is not a major factor in selecting a strategy. The financial analysis of representative plans indicated that, for the same growth in demand, the borrowing requirement is generally similar for all strategies except those where price increases are used to supress demand. Under conditions of upper growth in demand, all plans show a requirement for higher borrowing levels which could heighten issues regarding both desirability, and the availability of capital.

Based on the above considerations the strategy for new nuclear plant must recognize a preference for demand management, independent generation and hydraulic plant as defined earlier in the strategy. This will make a contribution to diversification in addition to the merits of those specific options. However, when new major supply is required there would be significant potential loss of benefit to Ontario Hydro's customers if the CANDU nuclear option was no longer available.

Therefore it is important that the CANDU nuclear option be maintained if this can be done at reasonable cost. Further detailed investigations and studies will be necessary to define the actions needed and assess the costs and feasibility of maintaining the CANDU option. A successful outcome from these studies will be highly dependent on the involvement and cooperation of all the principal participants in the Canadian nuclear industry including Ontario Hydro, AECL and the federal and provincial governments. Also, the principal stakeholders will each have a key role to play in the solutions.

11.5.9 Fossil

5.9 Ontario Hydro will maintain and improve its knowledge base of new developing coal burning technologies that promise reduced emissions and/or increased flexibility.

New fossil fuelled plant, particularly coal, is one of the options least favoured by the public mainly because of concerns about acid rain. As indicated in Chapter 5, Ontario Hydro is committed to meeting an acid gas emission control order which will limit emissions by 1994 to about 40% of the levels of the early 1980s. The analyses of options and representative plans included measures to meet this regulation even if new coal plants were added. The effect of the regulation is that, if the amount of energy generated from coal is greater, the control measures must be more effective and will probably be more costly. Ontario Hydro can meet the regulation even with new coal plant but the cost will be high (Chapter 10).

Despite the relatively high cost, the analysis of representative plans shows that there are situations, particularly with higher load growth where new fossil fuelled plant is the most economical way to maintain a reliable supply. There may well be times when new fossil plant is selected based on Strategic Consideration 5.1. In addition, coal is one of the more plentiful energy resources (Chapter 3).

There is no need for Ontario Hydro to have a specific strategy to maintain the existing fossil fuelled technology because it is a technology that is widely used and available from a variety of suppliers in several countries. However, new coal burning technologies are being developed. Some of these such as fluidized bed combustion and integrated gasification combined cycle (IGCC) hold promise of cheaper or more effective control of acid gas emissions. IGCC also has some potential advantages from a flexibility point of view, since the plant can be built in stages.

11.6 Purchases

6.1 Ontario Hydro will continue to depend on neighbouring systems for emergency support to a level that is consistent with mutual benefit.

6.2 Long term firm purchases of hydraulic power from neighbouring provinces will be considered as an acceptable alternative to building new supply facilities.

Ontario Hydro operates as part of a large interconnected system. Among the advantages of operating this way are purchase and sale transactions which are not planned a long time in advance. In emergencies such as forced outages of generating units or transmission lines in Ontario, power flows into Ontario from neighbouring utilities automatically. Such transactions may be sustained during the emergency or longer if they remain available and are economic. Opportunities also present themselves from time to time whereby a neighbouring utility has surplus generating capability which can produce energy at a lower cost than Ontario. These kind of economy arrangements are generally not planned too far in advance and are for periods as short as a day to as long as six months or perhaps several years.

Because Ontario and its neighbours are interconnected, each system is more reliable than it would be if the systems were all separate. For example, if Ontario were to have a shortage of generation today, because of some emergency or unforeseen circumstance, there is a good chance that one of the other utilities would have spare capacity and could help.

This allows all utilities in the interconnected system to install less reserve capacity. No one utility should depend unduly on this emergency support, without arranging to purchase such support from a utility with surplus, since this would lead to that utility taking a disproportionately large share of the benefits. Such a utility would frequently need support but rarely be able to give it in return.

As indicated in Chapter 5, capacity requirements are 700 MW lower because of reliance on emergency support from interconnected systems.

Besides these kinds of short term transactions, Ontario Hydro could contract to purchase firm power and energy from its neighbours. This type of purchase requires the selling utility to commit to ensuring that power and energy are available as contracted. It may be surplus power, or it may start off as surplus power, but it is likely that the selling utility will eventually have to install generation to meet its obligations. On the other hand the purchasing utility is able to defer construction of generation. These contracts are for many years duration and are negotiated many years in advance of delivery so that there is time for the selling utility to build facilities.

There are favourable and unfavourable characteristics to purchases relative to the other options which must be weighed.

A purchase of electricity generated by a hydroelectric source in another province makes use of a renewable resource. It is indigenous to Canada and it provides energy diversity for Ontario. In addition, the environmental impact in Ontario is limited to transmission lines.

On the other hand, most jobs associated with a purchase would be located outside Ontario. Flexibility would be limited because of long lead times to negotiate contracts, obtain regulatory approvls and build hydroelectric facilities and major transmission Lines. In addition, Ontario would not have direct control of the construction and so would have limited ability to alter timing to match changing estimates of needs. Purchases have to be renegotiated at the end of the contract term at price levels current at that time or else replaced with some other option. Since contracts usually last a shorter time than the life of major generating plant, the need to renegotiate or replace would likely occur earlier with purchases. Some of the disadvantages of not owning the facility could be reduced if it was mutually agreed that Ontario would take an equity interest, giving a share in the ownership of the plant.

The capital cost to construct new hydroelectric generation and transmission in Quebec or Manitoba will likely be as high or higher than the capital cost of major coal or nuclear facilities in Ontario. The seller may elect to finance such projects on its own or it could require assistance from the purchaser. Either way, the price ultimately struck will have to cover the cost of financing.

Purchases can provide access to large hydroelectric resources in other provinces. In the past Ontario Hydro has found purchases of firm power and energy as useful, dependable and economical sources of supply. At this stage in negotiations it is not clear that purchases will be economic compared to other options open to Ontario Hydro. Nor is it clear, at this stage, how the trade-offs of other advantages and disadvantages will balance out.

Purchases are an option which should be considered from time to time when there is a prospect of being able to come to mutually advantageous terms.

12. DRAFT DEMAND/SUPPLY PLANNING STRATEGY

The Demand/Supply Planning Strategy must be consistent with the Corporate Goal which is:

> "to meet the requirements of the Ontario community for electric service, including the manner of its provision, so as to result in the greatest overall benefit to that community and in the lowest cost (customer's average unit energy cost) to the customer for that service over the long term".

Each annual Demand/Supply Plan will be developed based on the following strategic considerations:

1 General Strategic Principles

1.1 The primary objective of demand/supply programs is to contribute to customer satisfaction.

1.2 Reliability is paramount.

1.3 Low customer cost is vital.

1.4 Ontario Hydro must ensure that its activities are conducted in an environmentally and socially acceptable manner.

1.5 Rates must continue to be based on costs.

2 General Demand/Supply Strategies

2.1 Measures of Cost

2.1.1 Ontario Hydro will aim to develop a mix of demand and supply options that provides electricity service to customers at lowest total customer cost.

2.1.2 The cost of meeting social and environmental requirements will be included in cost evaluations of demand/supply options.

2.2 Response to Uncertain Growth

2.2.1 The load forecast will include upper and lower projections that cover a reasonable range of possible outcomes.

2.2.2 Contingency plans must be prepared that identify practical options to respond to upper and lower load projections.

2.2.3 Demand options will be implemented, and supply options will be committed, in time to meet the most likely load growth economically and reliably.

2.3 Resource Smoothing

2.3 To maintain flexibility and to reduce costs resource smoothing will be considered.

2.4 Resource Preferences

2.4 Resources meeting the basic criteria of low cost, reliability, flexibility and quality will be preferred based on the nature of the primary energy source in the following order:

- electricity efficiency, renewable energy and waste fuels;
- plentiful fuels;
- scarce fuels.

and based on their source in the following order:

- Ontario indigenous resources and electricity efficiency;
- other Canadian resources;
- foreign resources.

2.5 Public Consultation

2.5 Consultation with customers, the public, governments and the legislature will continue to be an integral part of the planning process.

3 Demand Management

3.1 Demand Reducing Options

3.1 Demand reducing options will be pursued to the full extent they are economic compared to the available supply options in the relevant planning period.

3.2 Load Shifting Options

3.2.1 Demand management programs aimed at shifting demand from peak to off-peak times will be selected to respect system limits on the usefulness of load shifting.

3.2.2 The choice between load shifting and energy storage will reflect the costs and benefits of each option.

3.3 Demand Increasing Options

3.3 Demand programs aimed at increasing demand will be pursued where they provide benefits to customers in total.

3.4 Cooperation with Municipal Utilities

3.4 The planning and implementation of demand management options will be undertaken in close cooperation with the municipal utilities.

3.5 Timing of Demand Management

3.5.1 Development and implementation of economic demand reduction programs should be started early enough to be effective in contributing to the most cost effective demand/supply balance.

3.5.2 Priority should be given to influencing the new market rather than the retrofit.

3.6 Demand Management - Research and Development

3.6.1 Technical research and market development to support existing and planned demand management programs will be given a high priority so that demand options can be efficiently implemented in a timely manner.

3.6.2 To provide flexibility, technical research and market demonstration programs shall be undertaken to provide information on the potential for new demand management programs.

3.7 Demand Management - Promotion & Education

3.7 Education, information dissemination, audits, and advertising will be pursued to make customers aware of the opportunities for the efficient and effective use of electricity.

3.8 Rate Induced Demand Management

3.8.1 General rates will be based on average costs.

3.8.2 Rates may be time differentiated to give incentives to shift load to off-peak periods.

3.8.3 Special rates for non-standard conditions of service may be implemented to manage demand for specific purposes.

3.8.4 Special rates should recover at least the additional cost of supplying the electricity sold under these rates.

3.9 Financial Incentives for Demand Management

3.9.1 Incentives should be high enough to encourage the development of a large part of the potential that is beneficial to customers in total.

3.9.2 Customers who participate and receive direct benefits should provide a substantial contribution to the cost.

3.9.3 The level of incentives should be acceptable to customers in general.

3.9.4 Financial incentives should be based on lifetime benefits; loans and grants may be used to increase the return to customers in early years.

3.10 <u>Energy Efficiency Standards</u>

3.10 Ontario Hydro will work with governments, industry and customers towards developing standards for buildings, appliances, etc, including the highest electrical energy efficiencies that are widely acceptable.

3.11 <u>Other Barriers</u>

3.11 Ontario Hydro will identify other barriers to increased efficiency and work with other parties as appropriate towards the reduction or elimination of such barriers.

4 <u>Independent Generation</u>

4.1 Rates for purchasing power from independent generators and incentives for independent generation projects shall be up to the avoided cost to the system as a whole.

4.2 Rates and incentives for independent generation may vary because avoided cost depends on many factors, including the reliability, timing and location of the deliveries.

4.3 Ontario Hydro will regularly communicate the need for independent generation to potential independent generators; request proposals to contribute to that need; and negotiate detailed terms and conditions with suppliers whose proposals have potential to satisfactorily meet the need.

4.4 Ontario Hydro will establish standard rates for purchases of independent generation having a capacity of five megawatts or less. The standard rates for hydroelectric or other renewable sources will be set at the full avoided cost.

5 <u>Supply Options</u>

5.1 <u>Supply General</u>

5.1 Major increases in supply will be provided by the lowest cost supply or purchase options available to meet the need after allowing for the effects of demand management and independent generation.

5.2 <u>Supply Approvals</u>

5.2.1 Ontario Hydro will seek improvements to the planning approval process to provide increased flexibility.

5.2.2 Approval for new transmission to incorporate new generation shall be sought as part of the generation approval process.

5.3 Unit Sizes, Plant Size and Flexibility

5.3 Single or two unit commitment of economically sized units in multi-unit stations will be considered to maintain flexibility.

5.4 Site Acquisition

5.4 New sites for major generating plant shall be sought to allow generating stations of economic size to be built while maintaining a geographical balance of electricity demand and supply.

5.5 Existing Plant

5.5.1 A high priority should be given to maintaining and improving the performance of the existing supply facilities.

5.5.2 Rehabilitation or redevelopment of existing facilities should be assessed along with the other demand and supply options.

5.5.3 To provide a flexibility margin, consideration should be given to retaining in a preserved state existing plant that has reached the end of its useful life.

5.6 Alternative Generation

5.6.1 Ontario Hydro will continue to investigate the technical and economic feasibility of alternative generation sources, particularly those that use renewable and Ontario resources.

5.6.2 Ontario Hydro will implement alternative generation sources in specific situations (eg, isolated systems) where they are the most beneficial alternatives.

5.7 Hydraulic

5.7 The economic hydraulic developments should be undertaken in an orderly program.

5.8 Nuclear

5.8 Ontario Hydro will seek to maintain CANDU nuclear so that it is available for future development.

5.9 Fossil

5.9 Ontario Hydro will maintain and improve its knowledge base of new developing coal burning technologies that promise reduced emissions and/or increased flexibility.

6 <u>Purchases</u>

6.1 Ontario Hydro will continue to depend on neighbouring systems for emergency support to a level that is consistent with mutual benefit.

6.2 Long term firm purchases of hydraulic power from neighbouring provinces will be considered as an acceptable alternative to building new supply facilities.

13 Glossary of Terms

ALTERNATIVE ENERGY/TECHNOLOGY: This term is used to describe energy producing or harnessing technologies not widely used. They generally use renewable resources in small, decentralized installations. Examples are photovoltaics, solar heating, wind generation and wood and waste fuelled generation.

ADVANCED APPROVAL: An approval to develop facilities which is obtained in advance of the date at which acquisition of materials must start. Such an approval would not be acted upon until the need arises. (Also referred to as 'Banked Approval').

AVERAGE DEMAND: The demand on, or the power output of, an electric system or any of its parts over an interval of time. Average demand is calculated by dividing energy by the number of hours in the interval. Average demand is expressed in kilowatts, megawatts, etc. (See Power Units.) In 1985, the average demand of the typical Ontario residence was about 1.2 kW while the average demand placed on the Ontario Hydro system by Ontario customers was about 13,250,000 kW (13,250 MW). (Also referred to as 'Average Load', 'Average Power' and 'Average Energy Demand'.)

BANKED APPROVAL: (See Advanced Approval)

BASE LOAD GENERATION: Those generating facilities within a utility system which have low operating costs and which are therefore run as much as possible, in order to minimize system operating costs. Except for maintenance periods, base load generation is usually run all the time. In Ontario this includes nuclear and some hydraulic generation.

BULK ELECTRICITY SYSTEM (BES): The generation and high voltage transmission facilities (generally 115 kV and up) considered as a whole.

CAPACITY: The greatest load which a unit, station or system can supply. Capacity is usually measured in kilowatts, megawatts, etc. (See Power Units).

CAPACITY FACTOR: Total actual output of a unit or station as a proportion of the output that would result if it was run at capacity over the same time period. Capacity factor is usually expressed as a percentage.

$$\text{Capacity Factor} = \frac{\text{Energy}}{\text{Capacity x Time}} \times 100\%$$

COGENERATION: The generation of electricity in conjunction with the production of useful heat, usually steam, for industrial purposes. Where an industrial firm wishes to generate both steam and electricity, it is often more energy efficient and cheaper to generate the two together rather than separately, or to generate steam and buy electricity. Cogeneration plants are usually fuelled by oil, natural gas or wood waste.

COMMITTED RESOURCES: Once a decision has been made to construct a particular facility or implement a particular demand management option, the resulting resource is said to be committed. Commitment of supply additions follows approval under the Environmental Assessment Act and requires a decision by the Ontario Hydro Board of Directors to be confirmed by the Provincial Cabinet. Commonly used to refer to BES additions, the term is being increasingly applied to demand management programs and studies. (Hence the use of committed 'Resources' rather than committed 'Generation'.)

CONSERVATION: The wise use of all resources including increasing efficiency of use, reducing consumption of scarce resources and reducing waste. Energy conservation may mean using more of one type of energy efficiently to replace an inefficient use of another, resulting in an overall reduction in energy use. Thus, energy conservation and electricity use reduction are not synonymous.

DEMAND: (1) In economics, the desire of purchasers for a commodity, usually inversely related to price. Demand for electricity also varies with time of day, season and economic conditions.

DEMAND: (2) In the electrical industry, 'Demand' is often used synonymously with 'Power' which is the rate at which electric energy is delivered at a given instant or averaged over some designated period of time. It is expressed in kilowatts, megawatts, etc. (See Power Units.)

DEMAND MANAGEMENT: Actions taken by a utility or other agency intended to influence the amount or timing of customers' use of electricity. These actions can be divided into three groups: load growth; load shifting; and load reducing, which usually involves efficiency improvements.

DEMAND/SUPPLY OPTION: This term is used to describe technologies, techniques or programs which could be used to meet future electrical needs. Demand options are those which could be used to reduce electrical needs or the rate of growth of those needs. Supply options are additional generating plants or improvements to, or extending the lives of, existing plants.

DISTRIBUTION SYSTEM: Facilities (lines, transformers, switches, etc) used to distribute electricity over short distances from the transmission system to customers. Distribution is generally at relatively low voltage (44 kV and less).

DIVERSITY (OF LOADS): The peak demands of all customers do not all occur at the same time. Therefore the peak demand placed on an electrical system is significantly less than the sum of the peaks of the individual customers. This difference is called diversity, and must be considered when developing a load forecast based on the individual forecasts of many customers.

DIVERSITY (OF SUPPLY): Diversity is also used in this report to describe a system having a variety of types of generation, using a variety of fuels.

ELECTRO-TECHNOLOGY: A technology that uses electricity in its processes, especially new applications of electricity, including those that displace the use of other energy sources. For example, the use of electrically driven heat pumps for kiln drying wood in place of air heated by on-site fuel combustion.

ENERGY: The ability to do work. Electric energy, the product of power and the time over which it is used or produced, is commonly measured in kilowatthours. (See Energy Units.)

ENERGY UNITS:

WATTHOUR (Wh): A small unit of measure of electrical energy. One watthour is the energy used in one hour by a device that uses one watt of power. For example, a 100 watt light bulb will use 100 watthours if left on for one hour. Similarly, a 50 watt bulb must be left on for two hours for it to consume 100 watthours of energy. The watthour is usually augmented by a prefix to create more practical, larger units:

Prefix	Abbreviation	Multiplier
kilo	k	10^3 or 1,000
mega	M	10^6 or 1,000,000
giga	G	10^9 or 1,000,000,000
tera	T	10^{12} or 1,000,000,000,000

KILOWATTHOUR (kWh): One kilowatthour equals 1000 watthours. Ten 100 watt light bulbs or a typical clothes iron would consume 1 kWh if left on for one hour. The kilowatthour is the unit of measure of energy which may be most familiar to customers, as it is the unit appearing on electricity bills.

MEGAWATTHOUR (MWh): One megawatthour equals one million watthours or one thousand kilowatthours. The average Ontario household uses just over 10 MWh in one year.

GIGAWATTHOUR (GWh): One gigawatthour equals one billion watthours or one million kilowatthours. The average large industrial customer of Ontario Hydro uses over 150 GWh in one year.

TERAWATTHOUR (TWh): One terawatthour equals one billion kilowatthours. Energy made available by Ontario Hydro to Ontario customers in 1985 was about 116 TWh.

ENERGY SERVICE: The task performed by energy. Some services are commonly fuelled by only one energy type, while others may use a variety. For example, storage of perishable food is a service usually provided by refrigerators run by electricity. Cooking may employ natural gas or electricity while space heating can be provided by electricity, natural gas or oil.

FORECAST RANGE: Since the future cannot be predicted with absolute accuracy or certainty, the forecast of future needs for electricity is presented as a band rather than a single value. The width of this band is called the Forecast Range.

GENERATING UNIT: A generator together with the device turning it. A generating unit can usually operate independently of other units in a multi-unit generating station.

GIGAWATT (GW): (See Power Units.)

GIGAWATTHOUR (GWh): (See Energy Units.)

GROSS PROVINCIAL PRODUCT (GPP): The annual total value of goods and services produced within an economy. In this report it refers to the Province of Ontario. (Also known as Gross Domestic Product, GDP.)

INDEPENDENT GENERATION: In this report, independent generation means generation owned or operated by producers other than Ontario Hydro. These producers usually have generating plants for the purpose of supplying electric power required in the conduct of their industrial and commercial operations. The term also covers plants whose sole purpose is the sale of electricity to Ontario Hydro. Independent generation does not include purchases of electricity from out of province.

INTERRUPTIBLE RATE: A discounted rate available to large industrial customers who agree to have their electrical service interrupted or reduced during times of system capacity shortfall.

INVERTED RATE: A rate structure in which the unit charge for electricity increases as the amount of electricity used increases.

KILOWATT (kW): (See Power Units.)

KILOWATTHOUR (kWh): (See Energy Units.)

LOAD: See Demand (2)

LOAD FACTOR: The ratio of average load supplied during a period to the maximum load or peak demand in that period. Load factor may also be thought of as the ratio of actual energy consumed during a period to the consumption that would result if consumption had been at the period's peak level the entire time.

$$\text{Load factor} = \frac{\text{Energy}}{\text{Peak Demand x Time}} \times 100\%$$

Load factor can be used to describe individual customers or the entire system. The annual load factor of the Ontario Hydro system is about 68%.

LOAD SHAPE: A term describing the pattern of electricity use or production when demand is plotted against time. (Also known as Load Profile, Load Curve; refer also to Fig. 5.4)

LOAD SHIFTING: The shifting of electrical demands from one period to another, usually from high load to low load periods. Load shifting may result from direct control of customers' loads by the utility or from rate or other financial incentives. Load shifting can postpone the need for new capacity additions by reducing peak demand.

LOCKED-IN ENERGY: Energy production capability at a generating station which cannot be used because of inadequate transmission capability connecting the generating station to the Bulk Electricity System.

LOWER LOAD PROJECTION: This is a term used to describe a future in which load grows at the rate forecast by the lower end of the load forecast range.

MARGINAL COST: The cost of supplying an additional unit of output. When the extra output can be supplied by simply increasing production from existing plant the terms usually applied are, 'Short-Run Marginal Cost', or, 'Incremental Cost'. When the extra output cannot be supplied by existing facilities and new plant is built to supply the output, the term 'Long-Run Marginal Cost', is generally used.

MARGINAL COST PRICING: A rate structure in which prices are set at the cost of the last (marginal) unit of production, rather than at cost of production averaged over all output.

MARGINAL COST TEST: When demand management is considered a resource to meet future energy needs, some decision rule is required to determine which options should and should not be pursued. Under the marginal cost test, a demand option would be allowed if it required expenditure (by all parties contributing) less than or equal to the cost of the alternative supply option. (Also known as Societal Test; contrast with No Losers Test.)

MEGAWATT (MW): (See Power Units).

MEGAWATTHOUR (MWh): (See Energy Units).

MOST LIKELY LOAD FORECAST: The load growth described by the middle of the load forecast range. This is the load growth that would occur if all assumptions underlying the forecast hold true and forecast error is zero. In general terms this is the middle of the forecast range of load growth.

MOTHBALL: To retain in a preserved state equipment that is surplus to current needs or has reached the end of its normal life. Equipment that has been mothballed is not available for immediate use but, given sufficient preparation, may be returned to service if required in the future.

MULTI-UNIT GENERATING STATION: A plant containing more than one unit of generator, turbine and associated equipment for converting mechanical (eg, falling water), chemical (eg, the combustion of fossil fuel) or nuclear (eg, the fission of uranium atoms) energy into electrical energy.

NATURAL CONSERVATION: Efficiency improvements that are undertaken by customers without direct financial incentives from the utility or government. Customers undertake natural conservation measures to reduce their electricity bills. (Contrast with Strategic Conservation.)

NO LOSERS TEST: A test which allows utility expenditure on a demand option up to a maximum, beyond which further expenditures would cause rates to rise above the level associated with installation of the alternative supply option. (Also known as Non-Participants Test; contrast with Marginal Cost Test.)

OFF-PEAK PERIOD: Periods during which relatively low demands are placed on a system. Times which are not included in the peak period. (contrast with Peak Period)

PARALLEL GENERATION: Independent generation which is linked to and in synchronization with the bulk electricity system. (See Independent Generation).

PEAK DEMAND: The maximum rate of energy consumption that occurs within a given period of time. Peak demand can refer to the maximum demand placed on a system as a whole, individual parts of a system, or individual customers or applications. In 1985/86 the peak demand on the Ontario Hydro system was over 20 GW. (Also known as 'Peak'; see Power Units.)

PEAK PERIOD: Periods during which relatively high demands are placed on a system. Ontario Hydro's daily system peaks usually occur in the late afternoon/early evening hours during the winter and the late morning during the summer. System load however tends to climb quickly in the early morning and stay relatively flat until late evening. Thus Ontario Hydro's peak period is generally defined as 7 a.m. to 11 p.m., workdays.

PEAKING CAPACITY (or, Peaking Plant): Generating stations which are normally operated only to provide power during maximum load periods.

PLAN: At Ontario Hydro, a resource plan is a scheme which identifies specific demand and supply resources proposed to meet the future electrical needs of the province, their timing and expected contribution. Plans are reviewed and revised regularly as circumstances change.

POWER: The rate at which electric energy is delivered. It is expressed in kilowatts, Megawatts, etc (see Power Units).

POWER UNITS:

WATT (W): A small unit of measure of power. The typical light bulb uses power at the rate of 100 watts. The watt is usually augmented by a prefix to create a more practical, larger unit:

Prefix	Abbreviation	Multiplier
kilo	k	10^3 or 1,000
mega	M	10^6 or 1,000,000
giga	G	10^9 or 1,000,000,000

KILOWATT (kW): One kilowatt equals 1000 watts. Ten 100 watt light bulbs would use 1 kW, as would a typical clothes iron or a large hair dryer. In cold weather, an electrically heated house would use about 10 kW.

MEGAWATT (MW): One megawatt equals one million watts or one thousand kilowatts. For example, 100 electrically heated houses would use about one megawatt as would a small industrial customer. The peak demand on the Ontario Hydro system is about 20,000 megawatts.

GIGAWATT (GW): One gigawatt equals one billion watts or one million kilowatts. The peak demand on the Ontario Hydro system is about 20 GW.

PRIMARY ENERGY: (1) Energy in its naturally occurring form (eg, falling water, uranium, coal, oil), before conversion to its end use, or secondary forms.

PRIMARY ENERGY: (2) Primary energy can also refer to electrical energy delivered to Ontario customers as opposed to secondary energy which generally refers to electricity exports.

RESERVE CAPACITY: The amount by which total system capacity exceeds the peak demand within a given period of time. Some reserve is required to maintain system reliability in anticipation of unexpected high demands or equipment failures. Planning reserve is the amount by which system capacity is planned to exceed forecast annual peak demand. The absolute amount of reserve capacity is usually expressed in MW; when expressed as a percentage of expected peak demand, the term 'Reserve Margin' usually applies.

RESERVES (as in natural resource industries): Resources which are known in location, quantity and quality and which are economically recoverable using currently available technologies.

RESOURCE: (1) In this report, both demand options (load shifting, efficiency improvements) and supply options (rehabilitation of old or construction of new generating facilities) represent resources which may be called upon to meet future electrical needs.

RESOURCE: (2) In general, a resource is anything that can be drawn upon to perform some function or meet some need. Besides natural resources, financial and labour are also considered resources whose availability must be considered when formulating plans.

RESOURCE: (3) In natural resource industries, the term is used to describe the total estimated amount of a mineral, fuel, or energy source, whether or not discovered or currently technologically or economically extractable; quantities of an energy commodity that may be reasonably expected to exist in favorable geologic settings, but that have not yet been identified, or cannot now be extracted because of economic or technological limitations, as well as materials that have not as yet been discovered.

RESOURCE-SMOOTHING: The scheduling of projects such that relatively smooth levels of human, material, and financial resources are needed.

SOCIETAL TEST: (See Marginal Cost Test.)

STANDARD COST: The cost of a demand or supply option calculated and expressed in such a way as to allow cost comparison of options having different lives, load or operating characteristics, etc. Standard costs in this report are expressed in constant (1984) dollars per megawatthour supplied annually. Standard costs are used only for preliminary screening and ranking of individual options.

STRATEGIC CONSERVATION: Efficiency improvements which would not be undertaken by customers based only on the value of savings available to them. Additional financial or other incentives, or removal of some other barrier by the utility or government is required. Such conservation programs are treated in an integrated planning process on a par with new generating capacity.

STRATEGY: In this report, a strategy is a framework or set of guidelines within which planning takes place.

TERAWATTHOUR (TWh): (See Energy Units.)

TIME-DIFFERENTIATED RATES: (See Time-of-Use Rates.)

TIME-OF-USE RATES: Rates which vary based on the time of day, day of the week or season of the year.

TIME SERIES MODEL: An equation or set of equations by which future values of some variable are predicted based on past behaviour of that variable.

TRANSMISSION SYSTEM: Facilities (lines, transformers, switches, etc) used to transport electricity in bulk from sources of supply to other principal parts of the system. Transmission is generally at high voltage (115 kV and above).

UPPER LOAD PROJECTION: This is a term used to describe a future in which load has grown at the rate forecast by the upper end of the load forecast range.

WATT (W): (See Power Units.)

WATTHOUR (Wh): (See Energy Units.)

14 SUPPLEMENTARY AND REFERENCE DOCUMENTS

Supplementary documents have been written to provide additional detail which could not be included in the main report. These papers are contained in a companion volume to the main report entitled "Draft Demand/Supply Planning Strategy - Supplementary Documents". In addition, there are numerous documents which are referenced in or lend support to the main report and supplementary documents. Most of these reference documents are Ontario Hydro reports which are available on request or in the Public Reference Centre. Many of these have been prepared as a part of the Demand/Supply Options Study.

Following is a list of the chapters of the Draft Demand/Supply Planning Strategy, along with the supplementary and reference documents which support them.

1. Introduction

2. Shaping the Future

Reference Documents:

Ontario Hydro; System Expansion Program Reassessment; Interim Reports 1-6 and Final Report; 1978.

______________; Reliability Criterion for Generation Planning, Report 603SP; 1981.

3. Ontario Energy Situation

Reference Documents:

Ontario Hydro; Long-Term Economic Outlook; September 1986

Government of Ontario, Ministry of Energy; Energy 2000; September 1985.

4. Electricity Requirements

Supplementary Document:

Load Forecasting Methodology

Reference Documents:

Ontario Hydro; Load Forecast Report 851209; March 1986.

______________; Load Forecast Report 861208; March 1987.

5. Capability of the Existing and Committed System

Reference Documents:

Ontario Hydro; 1986 Bulk Electricity System Resource Plan, Report 653SP; April 1986.

______________; 1987 Bulk Electricity System Demand/Supply Report, Report 661SP; April 1987.

6. The Need for New Resources

Reference Document:

Ontario Hydro; 1986 Bulk Electricity System Resource Plan, Report 653SP; April 1986.

______________; 1987 Bulk Electricity System Demand/Supply Report, Report 661SP; April 1987.

7. Criteria Used to Evaluate the Options

Reference Documents:

Ontario Hydro; Evaluation Perspectives for Cost-Benefit Analysis of Demand Programs, Report BESR87-7; January 1987.

______________; Demand/Supply Options Study - The Options, Report 652SP; February 1986.

8. The Options

Supplementary Documents:

The Options

Demand Management

Rates as a Demand Management Tool

Reference Documents:

Ontario Hydro; Meeting Future Energy Needs - An Initial Review of the Options, Report 651SP; November 1985.

______________; Demand/Supply Options Study - the Options, Report 652SP; February 1986.

______________; Ontario Impact of Hydro's Demand and Supply Options; Ecomonics and Forecast Division; May 1986.

9. Public and Government Consultation

Supplementary Document:

Public and Government Consultation

Reference Documents:

Ontario Hydro; Meeting Future Energy Needs - Provincial Organization Consultation Program:
Volume 1, The Consultation Process; Corporate Relations; May 1986.
Volume 2, Summary of Submissions; Corporate Relations; April 1986.
Volume 3, Submissions by Organizations; Corporate Relations; May 1986.

______________; Meeting Future Energy Needs - Regional Consultation Program; Corporate Relations; August 1986.

______________; Meeting Future Energy Needs - Regional Consultation Program Questionaire Results; Corporate Relations; August 1986.

______________; Meeting Future Energy Needs - Municipal Utility Consultation Program; Corporate Relations; December 1986

Goldfarb; Supply/Demand Options Study - Marketplace Analysis:
Volume 1, Executive Summary
Volume 2, Residential Consumers
Volume 3, Industrial/Commercial Consumers; April 1986.

Select Committee on Energy; Final Report on Toward a Balanced Electricity System; July 1986.

10. Analysis of Representative Plans

Supplementary Document:

The Analysis of Representative Plans

Reference Documents:

Ontario Hydro; Analysis of Representative Plans: The Plans, Report BESR8701; January 1987.

_____________; Transmission Aspects of the Representative Plans, Report 660SP, April 1987.

_____________; Financial Impacts of Representative Plans, Report BESR8702; September 1986.

_____________; Sensitivity and Risk Analysis of the Representative Plans, Report BESR8703; December 1987.

_____________; Analysis of Representative Plans: Social and Community Impacts; Corporate Relations; September 1986.

_____________: Provincial Economic Impact Assessment of the Representative Plans; Economics & Forecasts Report 706.01 (#352); January 1987.

_____________; Short-Term Resource Analysis of the Requirements of Representative Plans: 1986-1991, Corporate Programming Division; September, 1986.

_____________; Analysis of Representative Plans: Environmental Impacts - Generation, Report ES&A86193; August 1986.

_____________; The Optimal Level of Planning Activity, Report BESR8704; January, 1987.

_____________; Multi-Criteria Analysis of the Representative Plans, Report BESR8705; January 1987.

_____________; Discussion of Resource Diversity of the Representative Plans, Report BESR8706; January 1987.

_____________; Long-Range Financial Projection 1986-2006; Comptroller's Division; December 1986.

11. Strategy Elements

    Supplementary Document:

    Strategy Implementation - An Illustration

    Reference Document:
    Ontario Hydro; Overview of Electrical Service in Ontario; Speech by Tom Campbell to Select Committee on Energy, September 10, 1985.

12. Draft Demand/Supply Planning Strategy

13. Glossary